THÈSE

En vue de l'obtention du

DOCTORAT DE L'UNIVERSITÉ DE TOULOUSE

Délivré par :

Institut National Polytechnique de Toulouse (Toulouse INP)

Discipline ou spécialité :

Genie industriel

Présentée et soutenue par :

M. RONALD LEANDRO ELIZONDO

le mercredi 28 novembre 2018

Titre :

Méthodologie pour l'évaluation de la performance de l'amélioration continue des processus industriels

---

Ecole doctorale :

Aéronautique-Astronautique (AA)

Unité de recherche :

Laboratoire de Génie de Productions de l'ENIT (E.N.I.T-L.G.P.)

Directeur(s) de Thèse :

M. BERNARD GRABOT

Rapporteurs :

Mme VALÉRIE BOTTA-GENOULAZ, INSA LYON

M. SAMIR LAMOURI, ENSAM - ARTS ET METIERS PARISTECH

Membre(s) du jury :

M. BRUNO VALLESPIR, UNIVERSITE BORDEAUX 1, Président

M. BERNARD GRABOT, ECOLE NATIONALE D'INGENIEUR DE TARBES, Membre

Mme CAROLINE THIERRY, UNIVERSITE TOULOUSE 2, Membre

M. RAYMOND HOUE NGOUNA, ECOLE NATIONALE D'INGENIEUR DE TARBES, Membre

Acknowledgement

At first I thank God, Almighty, for being my guide and strength in times of trial for my own growth. A family is first in giving us teachings. Thus, it is our first school, where the principles and values that shape us during our lives are inculcated. God has blessed me greatly by allowing me to have a wonderful family that has always supported me, and has given me all its love and encouragement to carry out this adventure. Thank you for everything.

This research work has been carried out within the partnership between the Laboratoire Génie de Production (LGP) of the Ecole Nationale d'Ingénieurs de Tarbes (ENIT) and the Tecnológico de Costa Rica (TEC), thanks to an assignment from the Ecole Doctorale Aéronautique-Astronautique. Working here has caused me to push myself positively, and I am all the better for it, and I hope that my research can contribute to the success of the laboratory in the long run as well. I would like to express my gratitude to all the people who supported me and who contributed to the completion of this dissertation.

Foremost, I would like to express my gratitude to my Ph.D. director, Bernard GRABOT, for giving me the opportunity to unfold my potential and he has opened up plenty of new avenues of thought for me. Also, to my co-director, Raymond HOUE-NGOUNA, for committing to me on such a fascinating subject as this. I would like to sincerely acknowledge the efforts and gratitude for all the valuable time devoted to this research. Without the guidance and competence in the different topics covered, as well as the availability, I would never have been able to do such a task. I appreciate the human and academic skills that have allowed me to develop my job.

Likewise, my gratitude to Mr. Bruno VALLESPIR for chairing the jury of my thesis. At the same time, I must thank Mrs. Caroline THIERRY for his courtesy in being the judge of my manuscript. Furthermore, I would like to recognize Mr. Samir LAMOURI and Mrs. Valérie BOTTA-GENOULAZ for giving me the honor of being reviewers of this work. They have also contributed with their many remarks and recommendations to improve the quality of this research, for which I am very grateful.

Furthermore, I would like to thank all the SDC team, not only for their availability and the help they gave me throughout the development of this research, but for the friendship they always offered me.

I want to express my gratitude and friendship to all the people, both administrative at ENIT as well as the PhD students who have accompanied me along this journey for making me feel part of a family and for all the moments we have shared and beyond.

Contents

List of Figures

List of Tables

List of Acronym

BSC: Balance Scorecard

CEFOF: Technical Instructor and Personnel Training Centre for Industrial Development of Central America in the Republic of Costa Rica

HRM: Human Resource Management

JICA: Japan International Cooperation Agency

JIT: Just in Time

JMP: Japan Management Practices

JPC: Japan Productivity Centre for Socio-Economic Development

LP: Lean Practices

MTBF: Mean Time Between Failures

OEE: Overall Equipment Efficiency

Off-JT: Off the Job training

OJT: On the Job Training

OM: Operations Management

TQM: Total Quality Management

TPM: Total Productive Maintenance

TPS: Toyota Production System

SME: Small and Medium Enterprises

VA: Value Added

VAPM: Value Added Productivity Measurement

WCM: World Class Maintenance

Introduction

After more than 15 years in consultancy activities and working within companies, mainly on lean deployment, I have seen how powerful the lean tools and techniques are, but also how fragile the results can be. The purpose of this thesis is to come back to the basics for looking what has been lost during the successive transfers of lean principles from Japan to US, then from US to Europe and to suggest a more comprehensive methodology allowing to improve lean implementation, based on my practical experiments and on theoretical developments.

1. General Context

In a prevailing globalization climate where change is the constant, businesses must seek new ways to capture more customers; this can be achieved via differentiated products and services, but also via the efficiency of the production system allowing to decrease the prices. Undoubtedly, companies must be competitive if they want to be profitable and survive. In that purpose, they need to dramatically increase their performance, which can be done by adopting long-term management "*best practices*". This is not an easy task for organizations, supply chains and especially for Small and Medium Enterprises. As a consequence, the pursuit for competitiveness has prompted an eye to Lean Practices (LP), which has proven to be an effective approach to improve the businesses (Browning and Heath, 2009, Crute et al., 2003).

Through the adoption of Lean Practices, firms look towards the elimination of waste and activities without value added to the customer. Also, they foster an organization more flexible for swift modifications. However, an organization must encompass changing paradigms, starting with a solid commitment from the leadership, to reap the advantages of Lean. Therefore, a manager's success implementing LP depends on the organisation's capability to adjust to change.

This requires a whole management philosophy behind it (Dombrowski and Mielke, 2014, Martinez-Jurado et al., 2014), in order to allow a long-term transformation process within the business.

2. Findings and Problem Statement

The effective application of Lean entails a shift in corporate culture, from upper echelons towards lower levels throughout the organization. Many experts and scholars agree on the LP benefits, as well as in its complex implementation and in the inability of some companies to maintain the results over time. The literature proposes different overlapping features and explanations about the void mentioned before, but two main causes can be identified.

Firstly, an unbalanced relationship between people (social side) and tools and techniques (technical side). Both of them have been widely studied, but independently, by Lean specialists. Nevertheless, still, the confusion remains on how to connect employee's contributions to Lean and to recognize them as a key enhancer over Lean implementation process (de Menezes et al., 2010). There are not enough research studies that examine human resource management associated with the LP implementation phase (Martinez-Jurado and Moyano-Fuentes, 2014, Martinez-Jurado et al., 2014). In addition, there is no deep knowledge on employee involvement regarding Lean implementation (Schonberger, 2007).

Secondly, there is low leadership encouragement from senior management (Losonci et al., 2011, Taylor et al., 2013, Dombrowski and Mielke, 2014) as a result of a misconception of the purpose of Lean along with its responsibility and simplicity in addressing it. Managers also expect positive results in the short term. Given this, leaders must commit themselves to the organization's intention of new and improved behaviour, setting the example and living the change (Dombrowski and Mielke, 2014).

On the other hand, Lean is an evolved version of the Toyota Production System (TPS), which implies that Lean and TPS should be based upon the same foundation. Nevertheless, Lean implementation has often somehow omitted a critical component of the Japanese management perspective: the holistic Productivity approach, which is the pillar on which Japan had begun the attitudinal change and had also addressed the pitfalls associated with leadership. This approach balances purpose, people and process performance for continuous improvement.

Another point to be considered is that, traditionally, LP has been applied as a "*deterministic system*" with linear links between causes and effects, the whole system being broken down into individual elements. Then, those parts can be isolated and analysed to easily identify simple linear interactions to solve them. At that point, it is needed to put all the elements back together again to achieve the output planned.

Nonetheless, Lean is much more complex than that; it is a non-linear and dynamic system, whose elements constantly interact with each other. Therefore, the problem of LP implementation should be solved by considering it as a system of systems, in such a way to narrow the alignment gap between the firm's purposes and the company's improvement efforts. Clearly, both are correlated and are critical factors to support the new management mentality; simultaneously, they will influence the company's performance over time.

Therefore, some questions come up:

- **What basic mind set to strengthen the existing culture could drive the Lean complex and dynamic transformation?**

- **How to measure the behaviour change and commitment proposed by Lean thinking while improving performance?**

3. Methodology and document structure

The aim of the thesis is to contribute to the knowledge on proposing a model for deploying Lean, especially for Small and Medium Enterprises (SMEs), by proposing a methodology of implementation based on a strong foundation. More specifically, the thesis will discuss and propose how to integrate the Productivity approach with Lean to form such foundation. The document is therefore constructed upon the following structure:

Chapter 1. Conceptual Panorama: the context of Lean is analysed in the business context and its main characteristics are presented. These specificities are structured according to some drivers in the organization that can prevent the maintenance of results over time.

This chapter concludes with a description of the threats (limitations and barriers) that companies experience with a new management system. Another part of the state of the art considers the importance of the productivity management approach to support the sustainable performance of LP and its expected gains.

Chapter 2. Hypotheses: I suggest interpreting these difficulties in reference to some concepts lost during the stage of transfer of the lean principles from Japan to US, then to Europe. From this evaluation, one can recognize the complexity of Lean implementation and the main pitfalls mentioned above. Another part of the research considers the discussion of the criteria established around the restrictions of implementation and measurement of LP performance along the supply chain.

The second chapter concludes with a critical analysis of the approaches suggested in the scientific literature to identify why these gaps and constraints affect the use of Lean as a transformation methodology in an industrial context. The product of this is due to a simplistic way of addressing the challenges encountered.

Chapter 3. Methodology: I suggest basing lean implementation on a more solid theoretical basis grounded in the original approach of holistic productivity and its relationship to continuous improvement. More specifically, a methodology is proposed for evaluating the performance of continuous improvement processes among supply chain partners. Drawing on a complex systems approach, it can help companies discover patterns of how elementary concepts fit together, and then distinguish how the system behaves. In addition, these configurations could

help to create a decision-making structure that addresses change and adapts it within a learning organization.

This chapter concludes with a series of metrics to evaluate Lean, always under a dimension of complex thinking. It takes into account the strategic, tactical and operational levels to guide the correct decision-making process.

Chapter 4. Validation: Some of my past experiences are interpreted according to the suggested framework for first validation. A set of case studies is analysed to verify the validity and level of credibility of each phase of the proposed methodology. The first case is a global corporation in the cement sector, which qualitatively validates the first phase of the main foundations and tools of productivity and kaizen. The second is an SME in the Costa Rican textile industry that illustrates the use of value-added KPIs to monitor and diagnose gaps in the value chain.

Conclusion and Perspectives:

The conclusion presents the contributions and limitations of the project by opening research opportunities in the field of continuous improvement in business. Our scientific contribution includes:

- A conceptual framework for analysis to conduct a literature review.

- A conceptual framework for analysing the literature on lean improvement initiatives.

- A strategic framework for adopting and aligning performance that guides manufacturers through the early stages of a transformation process for their development processes based on a Lean incremental improvement approach.

Chapter 1

State of the Art on Lean Production

Contents

1. Introduction

In the current global economic circumstances, a trend is discernible in businesses towards profitability and client-orientation (Hines et al., 2004, Mourtzis et al., 2016). Against this backdrop, any adoption within corporate governance has a critical impingement (Stainer, 1997, Sunaga, 2006). Numerous companies worldwide now have decided to launch Lean as a way to boost their performance and competitiveness (Bicheno and Holweg, 2016). Since the 90s, many specialists in the area have been influenced by its principles and are witnessing its benefits (Atkinson, 2010). Yet, these efforts that can be considered as "*short-term victories*", eventually come down since

they require hard work and support from the whole organisation (Almeida Marodin and Saurin, 2013, Fullerton et al., 2014). In addition, enterprises are facing many obstacles, which does not let them to sustain results in long-term (Almeida Marodin and Saurin, 2015).

Some people think that Lean Practices (LP) are a set of tools that adds value to the customer by eliminating waste (Atkinson, 2010, Rüttimann and Stöckli, 2016). Undeniably, this is an important aspect of it but very far from its real aim (Fullerton and Wempe, 2009, Bhasin, 2012). Additionally, in the literature, many proficient in the topic underestimate this management approach; its implementation is not an easy path to follow (Birdi et al., 2008). As Ohno (2012) has stated, each firm has to adapt it to its culture and requirements. Nevertheless, the general assumption is that Lean is a long-term strategy for improving performance within the whole organisation (Emiliani and Stec, 2005, Shah et al., 2008). Even more influential, it has complex managerial implications, so firms need to understand that there is a dramatic change involved; it is a new way to do things (Achanga et al., 2006, Seddon and Caulkin, 2007).

This chapter aims to provide a coherent framework of the current state of the art to study how LP has evolved in the face of challenges and complexity during its introduction. This review will be based on three major technical considerations combined with the LP findings. In the first place, technical transfer from Japanese experts given to the author; secondly, working experience acquired by the researcher and thirdly, documented knowledge from the literature review conducted in this field by many authors previously. These different points of view will allow identifying the constraints facing the Lean deployment endeavours.

2. What is Lean?

Today, this methodology has apparently become a well-known concept as it enhances management capability, delivers workflow reliability and generates profitability and competitiveness (Emiliani, 2000, Bicheno and Holweg, 2016). Many LP specialists have cited specific benefits, such as inventory turnover, reduced lead times for customers and more flexible production (Melton, 2005, Bhasin and Burcher, 2006). This is why it has influenced many organizations around the world (Åhlström, 1998, Dombrowski and Mielke, 2014). Inclusively, it has turned out to be a desired managerial style prompted by an abrupt expansion onto sectors including textiles, aeronautics, services, medicine, etc. along with its value chain (Crute et al., 2003, Browning and Heath, 2009, Martinez-Jurado and Moyano-Fuentes, 2014). Authors such as Gilbert (1990) for example, have considered that its application brings considerable cost reductions and cite success stories such as IBM, General Electric, Harley-Davidson, Westinghouse, Texas Instruments, Motorola, Hewlett-Packard and Intel.

The Lean term has begun when Womack, Jones and Roos wrote the book "*The Machine that Changed the World*" (1990). Its geneses can be traced back to the Toyota Production System (TPS) through a five-year investigation led by the writers. The origin is a request done by the automotive sector to the Massachusetts Institute of Technology seeking

to narrow the disparities among the Japanese and Western car industries (Womack et al., 1990). Daniel Jones (2013), chairman of Lean Enterprise Academy UK, has declared that "*Lean did not derive from theory but through observing practices at Toyota that were delivering superior performance in terms of goods, quality, efficiency (hours per car) and time to market for new products, leading Toyota to eventually become the largest car maker in the world*"[1].

In accordance with the bibliographical references examined, further technical and technological components exist that merge together to support the initiative. The first one is that there is a consensus on two major pillars of lean: adding value and eliminating waste (Liker, 1997, Melton, 2005). Value added being a measure of the wealth created by an enterprise, waste has been considered as an activity providing no value to the product or service, that the customer is unwilling to pay (Asian Productivity Organisation, 2015). Another important point is that Lean comprises five Principles (Womack et al., 1990, Emiliani, 2000):

- To create value from the perspective of the customer,
- To recognize all the stages of value addition through the value stream,
- To establish activities that make value flow,
- To pull - responding to customer requirements,
- To seek perfection by creating value through elimination of waste.

The latter will be the incorporation of a series of adjacent toolkits commonly adopted by companies. Some definitions made by APICS [2] are outlined in table 1.1, including 5S, Kaizen, Kanban, Value Stream Mapping, etc. (Castle and Jacobs, 2011). So far, there is no clear definition of Lean, despite its popularity. Designations are ambiguous or confused; it can often be found close terms like "*Lean Production*", "*Lean Management*", "*Lean Manufacturing*", etc. (Mi Dahlgaard-Park and Pettersen, 2009, Taylor et al., 2013). A number of authors have intended to define it (Lewis, 2000, Shah and Ward, 2007, Bortolotti et al., 2015); anyway the concept is constantly evolving (Hines et al., 2004, Shah and Ward, 2007). APICS, v3.11, has defined it as an "*approach to management that focuses on reducing or eliminating waste in all facets of the system*" (Castle and Jacobs, 2011).

Owing to the absence of a standard definition, several inconsistencies have been found in numerous publications where misleading definitions have been introduced (Emiliani, 2000, Bhasin, 2012). A typical sample is that practitioners have often confused managerial systems (e.g. Total Quality Management (TQM), Total Productive Maintenance (TPM) or Just in Time (JIT)) and tools like 5S, Kanban or value stream mapping (Hines et al., 2004, Lodgaard et al., 2016). In turn, this leads to uneven attention spurred by managers on LP tools (Emiliani, 2000, Taylor et al., 2013). From the author's angle, this is just a small portion of what is really achievable by the methodology and could jeopardize further development.

[1] Source: www.leanuk.org
[2] APICS: Association for supply chain management

Scope	Tools/ Technology	Definition by APICS
Tools	5S Program	3.11.5 Sort, set in order, shine, standardise and sustain are five terms beginning with the letter S used in creating a workplace suitable for lean production.
	Kaizen	3.11.7 It is the Japanese term for improvement. Kaizen is continuing improvement involving everyone both managers and workers. In manufacturing, kaizen is finding and eliminating waste in machinery, labour, and production methods.
	Kanban	6.5.4 It is a method of Just-in-Time production that uses standard containers or lot sizes with a single card attached to each. It is a pull system in which work centres signal with a card that they wish to withdraw parts from feeding operations or suppliers, indicating the need to replenish or produce more. A second card may be used to signal the movement of material.
	Value Stream Mapping	3.11.2 It consists of all the activities or processes necessary to deliver a product or service to the customer. Value stream mapping is a technique using Flow charts to identify the key elements and activities in the process and flow of information. In value stream mapping, each activity is identified as either a value- or non-value-adding activity. Lean management seeks to minimize and eliminate nonvalue- adding activities from all processes.
Business Management Strategies	Just in Time	It is the most important components of the Toyota Production System, it is a production system that promotes productivity. The main aim is "*to produce what is necessary for the proper amount and when needed*" (Schonberger, 2007, Asian Productivity Organisation, 2015)
	Total Quality Management	4.4.3 It is an approach to improving quality and ultimately customer satisfaction. The term was first used to describe Japanese-style management approaches to quality management. It relies on the participation of all members of the organization. The methods of implementing this approach are found in the works of Armand Feigenbaum, Philip Crosby, W. Edwards Deming, Joseph M. Juran, Kaoru Ishikawa and others. The overall goals of TQM are lower costs, higher revenues, satisfied customers, and empowered employees.
	Total Productive Maintenance	It is a business managerial methodology to maintenance the equipment. It is encompassed activities to prevent quality defects in the goods and equipment breakdowns (Bhasin and Burcher, 2006, Asian Productivity Organisation, 2015).
Other Schemes as complement of Lean	Six Sigma	4.4.4 It is a methodology that emphasizes reducing process variability and product deficiencies to improve product quality and customer satisfaction. In the theory, at a six-sigma level of performance, only 3.4 defects occur for every one million opportunities, assuming the process is operating within 1.5 standard deviations of the centre of the process specification.
	Supply Chain Management	3.0 Current ideology behind the supply chain is to apply a total systems approach to designing and managing the entire flow of information, materials and services from raw materials suppliers, through factories and warehouses and finally to the customer. The term "*supply chain*" comes from the visual representation of how organisations are linked together as viewed from a particular company. The chain has many service support operations that transform the inputs into products and services and the distribution and service providers that localize the product.

Table 1.1. Definitions of Lean concepts

With these differences in interpretation, it becomes evident that a closer look into the sources behind Lean is necessary. It is indeed grounded within notorious Japanese Management Practices (JMP) (JIT, TQM and TPM) (Holweg, 2007, Furlan et al., 2011, Taylor et al., 2013). These practices were all developed as corporate and entrepreneurial philosophical strategies in contrast against the traditional mass production framework, where the aim was to "*push*" the production (Atkinson, 2010, Furlan et al., 2011).

All these initiatives were originally created, firstly to achieve Japan's growth and

prosperity as a country and secondly to enable industrial competitiveness (Fukuda and Sase, 1994, Asian Productivity Organisation, 2015). In other words, upon the Japan Productivity Centre for Socio-Economic Development's (JPC) establishment, in 1955, this has led to a holistic perspective about Productivity (Shimada and MacDuffie, 1986, Fukuda and Sase, 1994, Leandro, 2007).

This philosophy served as a polyvalent and key axis for the resurgence of Nippon Industry (Stainer, 1995, Ohno et al., 2009). For the author, the TPS has emerged from this governmental post-war policy, which was a condition for strengthening competitiveness, in conjunction with Toyota Motor Company's innovative capacity (Hampson, 1999, JICA, 2011). This scenario was neglected when US professionals pioneered the Lean model and then launched it to the rest of the World with this lack (Lillrank, 1995, Štrach and Everett, 2006); the thesis will discuss this later. Another underlying and decisive factor in the Toyota System is the importance of people, who constitute the source of production development (Emiliani, 2000, Schonberger, 2007). Therefore, what is discernible is that the course of action for all these approaches has been to do things differently, transforming the mentality within the organization in accordance to principles familiar to everybody (Bhasin and Burcher, 2006, Womack and Jones, 2010).

There have been many success confirmations over a JMP deployment in different companies and sectors worldwide (Stainer, 1995, Yacuzzi, 2007, Atkinson, 2010). It proves that these methodologies do not have a "*cultural bond*" exclusively to Japan (Liker, 1997, Holweg, 2007, Schonberger, 2007). Lately, some western academics have demonstrated that the combination of those initiatives will bring competitive advantage and enhance performance to the companies (Birdi et al., 2008, de Menezes et al., 2010, Bortolotti et al., 2015).

Undeniably, there is a close link and some similarities between Lean and JMP (Liker, 1997, Hines et al., 2004, Holweg, 2007); the root is the same. Thus, in light of this premise, such an approach would have to be conceived as a whole and not as a set of procedures and instruments (Lewis, 2000, Bicheno and Holweg, 2016). Nevertheless, many authors consider that the human resources component has been ignored (Birdi et al., 2008, Martinez-Jurado et al., 2014, Bortolotti et al., 2015).

Conversely, other researchers, including Holweg (2007) have seen Lean as a strategic management model underscoring the creation of "*value*" for customers by delivering high quality products and services over time with a low cost (through waste disposal), a "*pulling*" methodology. This thesis will further delve on such concepts.

So far, it has been acknowledged how popular LP is as well as the competitive advantage offered to companies (Bicheno and Holweg, 2016). Nonetheless, it also has its doubts, including the omission of the human resource aspect due to this "*tooling*" focus factor (Birdi et al., 2008, Martinez-Jurado et al., 2014, Bortolotti et al., 2015). Yet, enterprises still struggle on how to align Lean's overall aims of behaviour change and profits with their organisational accomplishments and efforts (Lewis, 2000, de Menezes et al., 2010). The following sections will discuss factual evidences detected by the literature on the barriers that have been generated while introducing Lean.

3. Literature Review of the Lean Malfunctions

As already mentioned, when the market demands greater product differentiation, large companies exert huge pressure on their suppliers for efficiency improvements, particularly when SMEs face technological limitations in terms of flexibility (Grabot and Mayere, 2009, Moeuf et al., 2016). Therefore, flexibility seems to be an essential subject to ensure the firm's adaptation to more aggressive markets. LP represents a highly competitive background to achieve it; nonetheless, a lot of academicals and empirical experiences confirm its complexity (Bicheno and Holweg, 2016, Rüttimann and Stöckli, 2016). Indeed, there is widespread recognition that JMP has helped boost the yield of operations, e.g. 20% fewer defects per year, over 100% higher asset throughput, 95% machine availability, 80% less floor space, 75% reduced lead times (Pavnaskar et al., 2003).

This may be one reason why this type of strategy provides a feasible alternative for competitiveness enhancement regardless of the type of organisation (Kono and Clegg, 2001, Ohno et al., 2009). Yet, for many managers, even today, Lean has been limited solely to short-term operational efficiency (Shah and Ward, 2003, Hines et al., 2004, Joosten et al., 2009). Businesses are focused on tools that can provide some level of achievement to reach desirable outcomes and cutting the costs (Marcotte et al., 2008). Moreover, the good efficiency of large companies is conditioned by a good quality of processes, regardless of who the people are, but for SMEs, people are the main support behind greater performance (Grabot and Mayere, 2009). This brings another aspect from a sociotechnical angle; the application of business managerial methods inevitably generates further dynamics (Emiliani and Stec, 2005, de Menezes et al., 2010).

It is well known that those initiatives require hard work and discipline; even though, it is expected that many obstacles will appear (Kotter and Schlesinger, 1989, Khanchanapong et al., 2014). No business endures the long term unless it be able to reinvent itself (Emiliani, 2000, Halling and Wijk, 2013). What has already been said, the ultimate goal of these corporate schemes is to change the behaviour of the whole organisation; subsequently, the leader main task is to guide that transformation, however, it needs time (Kotter, 2007).

3.1. Identification of Sources of Lean hurdles and failures

Taylor et al. (2013) have broken down influential characteristics about LP from the employee's standpoint, in UK enterprises. They have divided the analysis in five themes (firm success, workshop environment and management; recognition and empowerment) and have identified and summarised the main aspects mentioned by the workers on these topics:

- Company's accomplishments are linked to attitudes, enthusiasm for change and leadership involvement giving confidence.

- Labour atmosphere looks towards to discipline for standards, flexibility-adaptability and failure not countenanced.
- The supervisor-employee relationship, hard targets and staff participation determine work management.
- Recognition and reward expectations are based on team gratification and non-financial acknowledgement.
- Empowerment refers to the importance of relevant training and regular reviews, continual assess and improvement.

We have previously remarked that, in the light of the fact that the JMP gave rise to Lean, it can be inferred that they have common characteristics (foundation, linkages and obstacles) (Emiliani, 2000, Holweg, 2007). Many performance shortcomings remain unresolved thereafter prompting a variety of authors who have given explanations about Lean's painful execution (Lewis, 2000, Shah and Ward, 2003, Furlan et al., 2011).

Over the 90s, for example, whilst the spread of JIT has been extensively studied, several implementation constraints were explored. Cravvford et al., (1988) have conducted an evaluation of thirty-nine US companies. They were concerned about the early operational hurdles encountered during the implementation stages. Those drawbacks were ranked onto two dimensions, and the outcomes of the work force and technical difficulties are summarized in Table 1.2.

Problem		**Resistance to Cultural Change**	**Top management support**	**Lack of organisational communication**
Scope	**Employee**	Poor union support	Lack of understanding	Bad communication with the shop floor
		Dearth to change by supervisors, foremen &,engineers	Unwillingness to commitment	Problems with accounting (both cost and reporting)
		Success scepticism of the programme	Misjudgement of the magnitude of change	
	Technical	Deficit of resources	Performance measurement	Other problems
		Lack of training or education	Obsolete Performance measures	Keeping quality during implementation
		Too many changes at a time	Individual incentives precluded	Shortage of cross-trained workers

Table 1.2. List of Technical and Human dimensions (Cravvford et al. 1988)

Nowadays, the LP has the same barriers within the organizations compared to JIT formerly. Numerous publications from different Journals dealt extensively with aspects like:

- Resistance to change (Shah and Ward, 2003, Melton, 2005, Scherrer-Rathje et al., 2009),
- Firms keep relying on consultants (Taylor et al., 2013, Dombrowski and Mielke, 2014, Martinez-Jurado and Moyano-Fuentes, 2014),
- Scarcity strategic vision (Achanga et al., 2006, Dombrowski and Mielke, 2014),
- Short-term standpoint (Hines et al., 2004, Lodgaard et al., 2016),
- A weak or non-existence interaction between the employees and tools and techniques and low leadership recognition (Bonavia and Marin-Garcia, 2011, Taylor et al., 2013, Dombrowski and Mielke, 2014),
- Lack of top executives commitment (Bhasin and Burcher, 2006, Scherrer-Rathje et al., 2009, Losonci et al., 2011).

Besides, Almeida and Saurin (2013) have undertaken a systemic literature audit, between 1996 and 2012, on the basis of 102 published papers. There are six main areas of scanning in the deployment of Lean: structuring and scope; factors that influence the implementation; application methods; assessment procedures; results of execution and its adaptation to other sectors. Figure 1.1 positions these specific domains and their interdependency. It could help to identify possible obstacles, such as the difficulties when introducing this business system, due to the fact that in many cases, it has been limited to only certain practices and principles, the unsuitable awareness of its complexity or deficiency of theoretical and pragmatic knowledge of the socio-technical scopes.

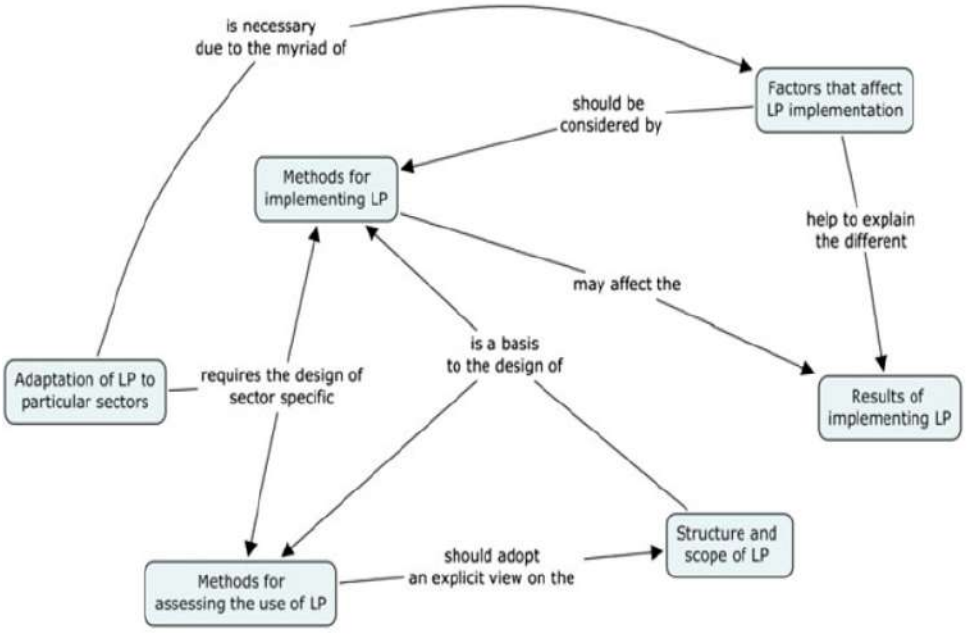

Figure 1.1. Relationship among research areas (Almeida and Saurin 2013)

Underneath these perspectives, it reveals that the application of Lean has failed in its ultimate purposes −organisational culture and sustain results overtime−(Lewis, 2000, Meade et al., 2010), both objectives engaged to value creation for the customer by taking away wasteful activities (Hines et al., 2004). Indeed, the real advantage of

LP should be the whole strengthening of the organisation through behaviour change (Bhasin and Burcher, 2006, Mi Dahlgaard-Park and Pettersen, 2009, Lodgaard et al., 2016). In the same regard, the Lean principles must be implicitly applied under a complex system perspective that allows an understanding of the work in each element of the network, whose structure is uncertain and convoluted (Sterman, 2002, Jackson, 2003).

On the other hand, many firms have not been able to endure Lean accomplishments for the long term. 43 cases of Fortune 500 companies including Kodak or Unisys suffered from a breakdown in gains after three years to release Lean (Bhasin and Burcher, 2006). Likewise, Meade et al., (2010) have identified a drop of the net profit in the trend of its early phases of LP. Interestingly, Lean objectives have strategic and operational scopes (Hines et al., 2004) meaning that at the end all its weaknesses are the responsibility of the head. The barriers come mainly from Management issues. In this matter, there is a research opportunity in this area concerning the interaction between LP practices and principles.

Within the literature reviewed, there are some key academic papers that point cultural and organisational dilemmas (Shah and Ward, 2003, Taylor et al., 2013). Both quandaries are considered as the most challenging to avoid the programme to stall. However, it is clear that these points are still a problem that has not been solved since the 90s. The next section will emphasise the support of this assertion through articles and case studies.

3.2. Threefold Scenarios Critical to Lean Deployment

In the literature, there is a huge number of investigations about the impact of "*Managerial topics*". Kotter (2007) has asserted, "*Too many managers do not recognise transformation is a process, not an event. It moves forward through steps that build on each other. Moreover, it takes years. Pressured to accelerate the job, top managers skip phases. But shortcuts never work*". Some articles and case studies will help to validate the findings and interactions of the different obstacles mentioned earlier. They will be grouped in three main categories: authorities' commitment, socio-technical factors and problems with Lean metrics.

3.2.1. Top Management Commitment Factor

The value of Lean depends on the authorities' administration style, which inherently influences the culture of any business (Saad et al., 2006, Bicheno and Holweg, 2016). Some experts of the Japan Productivity Centre for Socio-Economic Development (JPC) experts[3] mentioned that top management engagement could be accomplished through providing budget and time for projects and working side by side with them at the gemba (workplace) (Shimada and Sonobe, 2016).

[3]Kenji Takemura and Hajime Susuki, JPC experts, have asserted that expression based on-the-job training teachings in a consultation speech at Holcim Costa Rica, 2002.

This is a critical aspect that will directly influence the success of any business strategy. There is a chain reaction in the whole organisation when leader involvement is visible and real (Achanga et al., 2006, Lodgaard et al., 2016).

Almeida and Saurin (2015) gathered in a framework for managing LP obstacles a very interesting information based on a case study in a large hydraulic components manufacturer in Ohio, USA. The company adopted LP for more than 10 years. A summary of the Lean's chronological context at the firm is shown as follows:

- In 2003: six kaizen events concentrated on standardised work and 5S both in the administrative areas and in the shop floor.
- From 2003 to 2008: implementation of Value Stream Mapping used to design improvements. In 2008, a new director was working full time to LP.
- In 2008: the last kaizen event took place with the worker's participation. The head of the company has made the decision and he argued that the objective of that resolution was to boost the production manager contribution in LP.
- In 2011: another executive and a consultant employed to carry on a walk through the workplace; they pointed out ideas for improvements.

Based on the data gathered, they have identified the main obstacles found during the implementation phase. In Figure 1.2, the chart suggests a logical relationship to link hurdles that influenced each other. As an illustration, personnel have doubts to be responsible for new tasks (B9) this depends directly on the level of competence of authorities have on LP (B12). The magnitude of their findings supports the assertion associated with the importance of managerial commitment; since their influence is implied across Lean application and should be strengthened to enable feedback and decision making for greater profitability (Losonci et al., 2011, Dombrowski and Mielke, 2014).

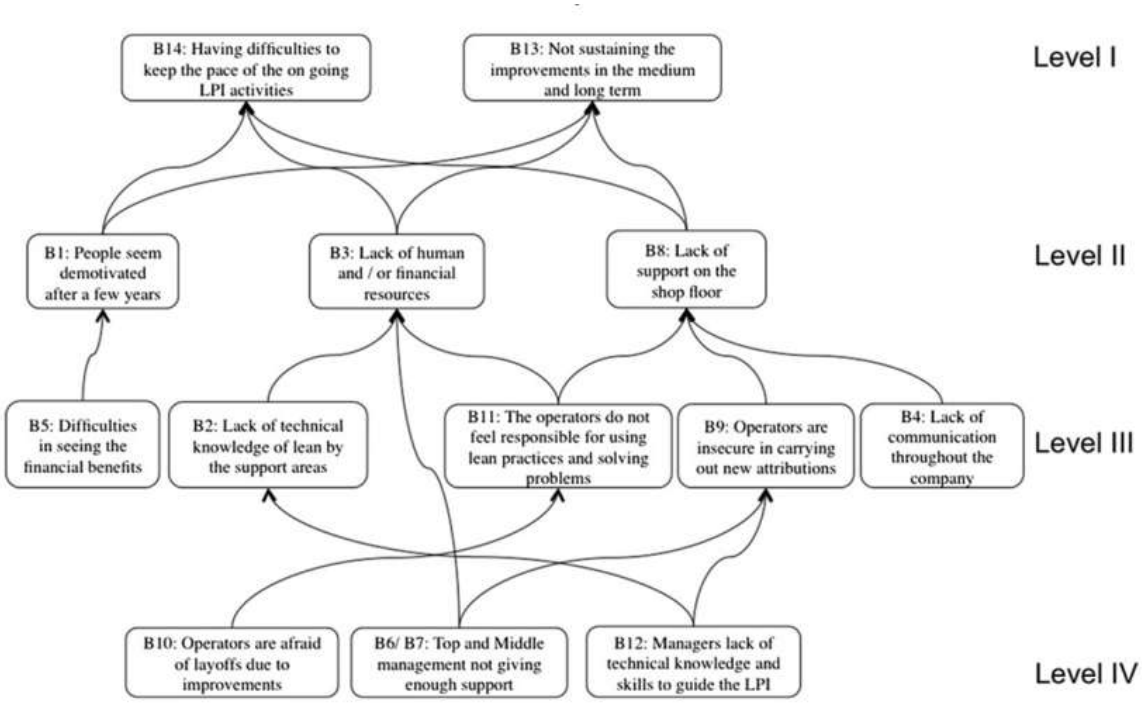

Figure 1.2. Causal relationship among barriers (Almeida and Saurin, 2015)

Conversely, Achanga et al. (2006) considered four constrain factors (leadership, finance, know-how and culture) in the progress of the implementation process, within ten UK Small and Medium Enterprises (SME). The majority of these enterprises' anxiety relies on the belief that applying Lean is expensive and time consuming. Their outputs have revealed a chain reaction deficiencies based on the need for adequate funding and leadership; specifically, on owner-manager's expertise, support and commitment. Another concern is that personnel training requires financial sources help. In fact, for SMEs, head viewpoint is an unnecessary loss of resources. In this respect, the deficit of employee education means low competences for them and, thus, the aim for a change of culture, essential platform in the application of Lean. The study has established that many are sceptical about the advantages of LP to their business, which was expressed by a financial scarcity, which rejects the opportunity to implement different productive initiatives. There is a direct connection concerning the SMEs management styles and numerous outputs such as return on investments or number of employees or lead-time.

As another aircraft sector lecture, Holweg (2007) has noted about the "*Lean Aerospace Initiative*", made in 1993 by the US Air force that the industry has encountered similar troubles caused by a lack of a concise spotlight. Crute et al. (2003) have performed a research within a single company over two different manufacturing sites under equal pressure for a better yield.

In factory A, LP with clear target indicators was applied during one semester. On the other hand, Plant B has had an 18-months period during which it was implemented with less challenging objectives. The feedback given was that execution best practices at site "*A*" are not replicable. Adaptations to other factories would require different purposes, awareness and metrics based on a strategically tactical LP perspective by the senior executive and, also, on an autonomous learning culture.

Likewise, Taiichi Ohno has advised that the TPS thinking background is to answer Toyota's own problems at that time; each plant is unique (Holweg, 2007, Ohno, 2012). Many Japanese experts have said "*do not copy-adapt*". Lean should not be as a "*fashion recipe*" matter (Leandro, 2007, Murata and Katayama, 2010).

Moreover, Browning and Heath (2009) have presented a paper about the F-22 Lockheed Martin's Lean manufacturing experience and its efforts on waste dissipation and production expenses. The project came for a cost reduction pressure from clients. This made that the executives had a myopic attention in just efficiency and timing, instead of an innovative way of thinking. These managers, without much day-to-day attachment at the shop floor, believe that Lean is a simple concept (Cravvford et al., 1988, Taylor et al., 2013, Lodgaard et al., 2016). They look forward to immediate results from their underlings, and have therefore a short-term point of view. As it can be seen, accomplishing LP is not a trouble-free assignment. The new mind-set begins with the authorities' commitment to generate big impacts (Emiliani and Stec, 2005, Pearce and Pons, 2013). Deming affirmed that "*The problem is at the top; management is the problem*". (Crute et al., 2003, Losonci et al., 2011, Dombrowski and Mielke, 2014)

The next case (Scherrer-Rathje et al., 2009) may clarify this assertion. In an international manufacturer of food processing machines and equipment, a first attempt failed in

1997 due to a lack of leaders' determination with Lean. However, in 2006, a second project was a success (at this point a former Toyota Japanese expert was paid to support the implementation).

The lessons learned from these carried on experiences were clear top management involvement was necessary, to establish a Lean long-run strategic vision, to encourage autonomy, to communicate targets in a mid-to long-term basis, so that a LP follow up through periodic evaluations. Senior authority engagement unswervingly influences on the firm's commitment, especially at the operational levels; it becomes a key part to Lean transition (Birdi et al., 2008). Breaking the normal resistance to transformations by working side-by-side with the employees in order to eliminate entropy (waste) in the process is a condition of success.

The main leader's job is to allow change (Anderson and Anderson, 2010, Atkinson, 2010). As Deming (1982) has reiterated, firstly, it is imperative for decision makers to set an identity within the system; indeed, every basic belief and value embodies the corporate culture (Evans, 1996, Drucker, 1999). Given this desire to change, the following questions arise (which will be addressed in the next chapter): what is identity needed to be displayed by the organization regarding LP strategy? Which is the function required from senior executives for initiating the change stemming from its principles?

3.2.2. Socio-Technical Factor

A solid foundation lies on a learning Lean framework to bear employee empowerment through training, company infrastructure and culture maturity, to be able to sustain improvements over time (Worley and Doolen, 2006, Joosten et al., 2009). The critical concern here is how to link and to recognise the worker's contributions as a key enhancer of the deployment process (de Menezes et al., 2010, Bernhauerova, 2013). In many firms, there is an uneven bond among the employee talent and techniques (Drucker, 1999, Cassell et al., 2006). People, organisational structure and culture are the social aspect; on the other hand, tools, methods and standards refer to the technical side (Martinez-Jurado and Moyano-Fuentes, 2014).

Such socio-technical considerations have been widely covered by the pundits (Hines et al., 2004, Taylor et al., 2013). Birdi et al. (2008) have for instance collected data on productivity achievement from 308 companies over 22 years. Figure 1.3 shows a summary of their findings, basically presenting the individual and collective impact of seven management practices related to yield (empowerment, training, teamwork, TQM, JIT, advanced manufacturing technology and supply chain alliances); fundamentally, such initiatives are also theoretically echoed in Lean. Their conclusions suggest that engagement roles detach as most probable to encourage firms' productivity. The expected results could be shown between 1 and 4 years after its introduction. Consequently, investing in teaching and education along with teamwork will enhance company performance and the other practices as well. However, the effects are variable and were not evident until 6 to 9 years after the application. Overall, empowerment and training are clearly linked with productivity; both displayed a 9% growth in value added per employee (Birdi et al., 2008). Besides, there is a

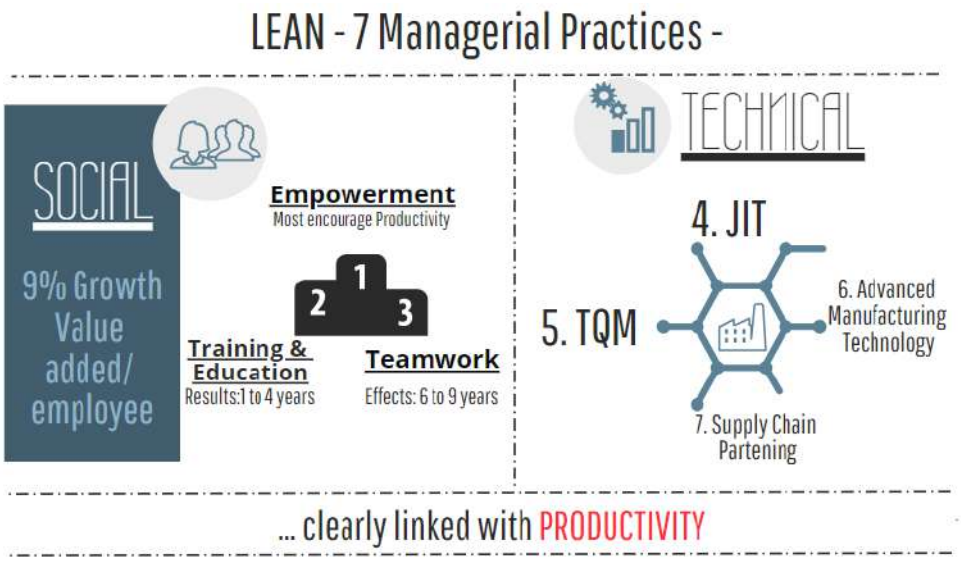

Figure 1.3. Survey overview showing linkage of HRM and OM practices (Birdi et al. 2008)

robust argument that the implementation process will directly affect the result of those practices.

In that sense, the work of de Menezes et al. (2010) deals with the potential nexus between Operations Management (OM) and Human Resources Management (HRM). For 24 years, they gathered data from UK manufacturers (this study seems to be a sequel to Birdi's research as it draws a similar pattern). This is reinforced in other writers (Gunasekaran and Ngai, 2012, Martinez-Jurado and Moyano-Fuentes, 2014, Bortolotti et al., 2015) all considering that productivity may measure performance instead of financial indexes. Their examination discloses that the amalgamation of outcome mapping and human resource management practices (socio-technical topics) are essential for the link between Lean and TQM and drives to better results.

Furthermore, their statement regarding that by having a consolidated and holistic system deployed reveals a managerial philosophy backed up by the data. Overall, the synergy between the socio-technical features has been acknowledged by academics and practitioners, as examples of together accomplishments and disappointments and their integration represents a key factor clearly linked with productivity and an enterprise's competitive advantage (de Menezes et al., 2010). This is consistent with other studies recently made by other researchers based on 730 manufacturing firms surveyed in France, Germany, UK and USA (Bloom and Van Reenen, 2011).

Already cited, Taylor et al. (2013) have explored an assembly plant between 2008 and 2010 with 5000 workers. They have discovered the employee's recognition connected with LP and the toughness for enterprises to uphold the "*momentum*" (results) overtime through commitment. Their interviews to staff were about the perception of the Lean system, specifically, in subjects like workplace atmosphere, labour development opportunities, effective workers managing, remuneration and recognition policies. Another factor measured was the Plant success with matters such as authorities' leadership; personnel skills and assertiveness and infrastructure on Lean.

The final topic was about the confrontation of keeping performance objectives and maintaining the programme and more precisely, the change management expertise. Table 1.3 shows a summary on Taylor's findings. This case study revealed some remarkable results; it can acknowledge that Lean is a business philosophy based on socio-technical practices. It is influenced by a complex interdependency between many different variables; particularly, the ability of the authorities to recognise the synergy of HRM into sustainable firm's long-term results. Nevertheless, a simplistic understanding displayed by the managers combined with cosmetic hands-on participation are weaknesses in most organizations (Schonberger, 2007, Lodgaard et al., 2016). Lastly, some of these facts suggest that 'goals, measures and KPIs' should be included as an alert in order to avoid complacency of short-term results.

To delve more aspects around Lean, Furlan et al. (2011) have analysed statistically the complementarity of the LP, JIT and TQM. The trial has relied on 266 factories (with a minimum of 100 employees) from Austria, Finland, Germany, Italy, Japan, Korea, Spain, Sweden and the USA, between 2005 and 2007. They have validated the synergy between JIT and TQM on operational achievement with the Edgeworth's theory of complementarity. The concept defines the complementarity of activities as "*if doing (more of) any one of them rises the returns to doing (more of) the others*". They have revealed that the departments who carry out those approaches have increased in productivity and quality levels, management and employee commitment and participation of suppliers compared with those who do not implement it. Additionally, HRM practices like teamwork, training or empowerment have positive and direct relationship with JIT and TQM. Their conclusions were that HRM is a requirement to unfold the tool-oriented focusing on Lean; companies must invest in those practices, or else, they cannot reap all the benefits of the complementarity between TQM and JIT.

To develop this new mind-set, the firm must design management systems that build up people '*on the gemba*'. It is just recently that some studies and surveys recognise the human talent as a key enhancer over Lean implementation (Birdi et al., 2008, Taylor et al., 2013). For that reason, the focus on the operational level is vital in order to apply the right tools and techniques to provide value to the customer (Hines et al., 2004, Browning and Heath, 2009, Taylor et al., 2013).

Birdi et al. (2008) asserted that "*the effectiveness of operational practices depends on human resources*". They continue saying that "*adopting empowerment and extensive training was the key to productivity*". Therefore, these socio-technical aspects are interconnected and will also influence directly the transformation needed, developing the objectives and enhancing process capability in the long term.

The conclusion from those cases is that it is a starring responsibility for authorities to coach their human resources in order to build a continuous improvement approach and, besides, to bring the opportunity to employees to develop their problem-solving proficiency. Hence, at that point, the organisation will be motivated; so, this is a reliable '*resistance to change*' disrupter (Dombrowski and Mielke, 2014). Nevertheless, the question of course is how to engage people with LP?

Area studied	Criteria	Percentage(%)
Perception of Lean system	**Opportunities for personal development**	
	Regular appraisal	95%
	Relevant training	81%
	Effective Labour management	
	Employee involvement	95%
	Demanding targets	90%
	Supervisor worker relations	86%
	Giving workers a voice	
	Suggestion Scheme	81%
	Listing of concerns	76%
	Two Communication way	72%
	Reward & Recognition system	
	Non-financial recognition	90%
	Team based reward	86%
Plant success	**Leadership from top management**	
	Personally involved	81%
	Credibility	76%
	Workforce Attributes and Attitudes	
	Flexibility, adaptability	90%
	Failure not countenanced	86%
	Belief that lean works	81%
	Corporate Systems Infrastructure	
	Continual review & improvement	95%
	Best practice sharing	90%
	Director level responsibility	86%
Challenges of maintaining performance levels and sustaining lean	**Change Management proficiency**	
	Attitude to change	95%
	Appetite to change	81%
	Maintaining momentum	76%

Table 1.3. Summary of the most important findings by Taylor et al. (2013)

3.2.3. Difficulties with the assessment criteria on Lean impact

Despite the popularity of the LP, in the UK, less than 10% of companies have been proficient implementing it, owing to the fact that its advantages are not clearly perceivable in the financial outlook (Bhasin, 2008). A number of survey studies have indicated that LP capacity concentrated on production objectives such as quality, flexibility, lead-time or delivery (Lewis, 2000, Bhasin, 2008, Fullerton and Wempe, 2009). Additionally, another important discovery established advises that Lean's performance goals should not focused merely on productivity indicators rather than profitability or financial KPIs measurements (Meade et al., 2010, de Menezes et al., 2010, Taylor et al., 2013).

Among Fortune 500 firms, a famous business journal has publicised that 43 out of 50 important companies from their list, including some such as Kodak and Unisys, suffered from a significant downturn in earnings after three years of implementing LP (Bhasin and Burcher, 2006, Lewis, 2000). Thereby, a good control structure turns out to be a vital aspect to provide feedback onto the outcomes concerning LP.

Meade et al. (2010) have observed the impact of Lean initiatives on the behaviour of the net profit (using four known accounting standards) during the implementation phase. A conclusion is that it may hard to balance in the short term between gemba savings carried by the LP. Especially, the inventory decrease drives to weakening fixed revenues because of a deficiency in financial and bookkeeping procedures.

In Table 1.4, it is shown that the study has identified the negative impact on the income statement resulting from rapidly reducing stocks (approximately a drop off in net profit of 1/3), established on the conventional accounting systems. Normally, once the inventories have traded, they are accounted as assets on the balance sheet; then, the expenses become a cost of goods, which would be added in the income statement. Therefore, if Lean displays a drop of final inventories, it will be registered at the income statement and not in the balance sheet without recognising them in the current period. This means a decrease in gains until the stocktaking of the finished goods are stabled.

Their conclusions have shown that the financial statements methods may perceive a reduction in revenues as a result of efforts to bringing down the stock levels in the short term. This could damage the LP expectations from the top managers and stakeholders if this discovery is not properly interpreted; a long-term is a foremost consideration. Even so, knowing that fact about the net profit diminishment, at early stages, linked to inventories, the authorities avoid the programme resistance because of an apparent lack of results by recommending establishing some complementary metrics that allow bringing a follow up of the improvements made by the workforce.

Fullerton et al. (2014) have investigated 244 USA firms, 49% of them having implemented lean. Over a period of three-years, they have discovered the direct bond existing around Lean practices to both operational and financial performance, which is critical for in-house decision-making. Their results have also revealed that such complex organizational strategy can enhance yield. This is in line with researchers who have argued that conventional accounting systems motivate disruptive behaviour

	Before lean	During lean
Net sales	100000	100000
Material cost		
Purchases	35000	23000
Inventory (material)±	-6000	6000
Total material cost	29000	29000
Processing cost		
Factory wages	11000	11000
Factory salary	2000	2000
Factory benefits	5000	5000
Services & supp.	2500	2500
Depreciation	2000	2000
Scrap	2000	2000
Total processing cost	24500	24500
Total manufacturing cost	53500	53500
finished goods inventory± (Labour & Overhead)	-4000	4000
Cost of sales	49500	57500
Gross profit	50500	42500
Gross profit (%)	50,5	42,5
Inventory carrying cost	1605	1471
Net profit	48895	41029
Net profit (%)	48,9	41,0

Table 1.4. Calculation of net profit (Meade et al., 2010)

against LP's success when focused solely on cost cutting without process or customer value improvement. Therefore, control systems need to be updated to reflect the underlying Lean vision. Lastly, they also have concluded that the support of other departments is of highest relevance (e.g. human resources, accounting and finance, etc.) and should become a principle for building the Lean team.

Fullerton and Wempe (2009) have considered 121 USA production directors from four sectors - chemical, industrial machinery, electronics and instrumentation- and have observed the magnitude of the liaison between LP and financial output with nonfinancial manufacturing performance measurements. They have depicted in a pattern, via Structural Equation Modelling (SEM) (Figure 1.4),their perception of the work force impact on production practices, which in turn indirectly influences the companies' financial performance.

Their conclusions endorse the belief that worker talent engagement is a critical aspect of success during Lean implementation, and the use of HRM practices encourage this statement. Tests suggest that HRM practices increase the impact of LP on profitability. If managers do not combine these aspects, the company may suffer from unsatisfactory financial effects. Moreover, the results acquired have shown that the bond between LP and profitability is linked to the ability of the system to align behaviour with strategic goals.

Yet, researchers found that neither TQM, JIT nor Lean were associated with output in the financial statements (Lewis, 2000, Rauch et al., 2017). This means, implicitly, there are few KPIs that allow the comparison of figures to illustrate trends in a

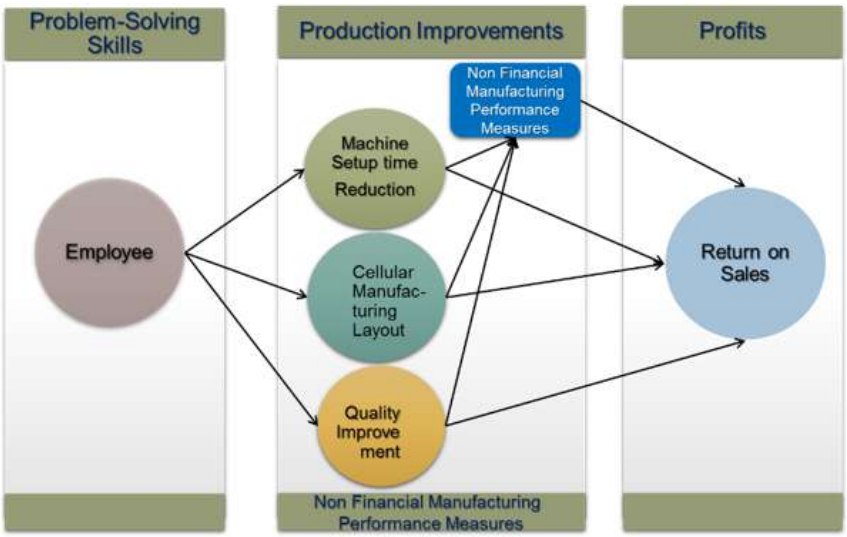

Figure 1.4. Model of LP, non-financial manufacturing performance measures and profitability (Fullerton and Wempe, 2009)

company's performance and their linkage to such managerial philosophies (Birdi et al., 2008, de Menezes et al., 2010). Consequently, many authors have underlined the need for a new structure to assess improvements made by LP, conventional accounting systems having several problems for informing those accomplishments (Maskell and Baggaley, 2006, Brosnahan, 2008).

In this matter, Brosnahan (2008) mentioned that Watlow Electric Manufacturing Co. has implemented a non-traditional method to evaluating and managing LP, called "*Lean accounting*". The concept was designed to better exhibit the business performance brought by the programme's practices such as value stream management and adjustment of bookkeeping reports (organising cost procedures and incorporating nonfinancial data) (Maskell and Baggaley, 2006, Maskell et al., 2011). The company found that traditional methods have many difficulties for quantifying the impacts of Kaizen activities; for that reason, specific measurements were developed to assess e.g. safety, cost, quality or delivery.

Maskell and Baggaley (2006) have illustrated the lean accounting approach with the example of a weekly report based on the value stream yield. As it can be seen in Table 1.5, there are both OM ratios (on time shipment, average cost) and financial indexes (return on sales, profit or revenue) that the in-plant workers use over LP accounting systems.

In conclusion of this section, Lean projects must be monitored and require a suitable measurement system based on productivity metrics but displayed in profitability parameters. It is difficult for decision makers to respond to challenging situations appropriately without proper financial and technical information (Fullerton and Wempe, 2009, de Menezes et al., 2010). Maskell et al. (2011) have emphasized that traditional accounting methods do not express the economic benefits of LP; it is necessary to use other techniques to identify their financial impact of the company. Yield assessments within Lean companies are essential to the control and improvement of the organisation. The authors have also noted that LP manufacturers

		Current State	Order using Standard Cost Std Cost = $42.44	Out Source to China Landed Cost =$30	Make in House Buy Additional Machines
Operational	Sales per Person	$ 29 789,00	$ 29 789,00	$ 33 647,00	$ 33 647,00
	On-Time-Shipment	95%	95%	90%	95%
	Dock-to-Dock Days	16,4	16,4	21,1	15,1
	First Time Through	80%	80%	75%	81%
	Average Cost	$ 29,95	$ 29,95	$ 30,18	$ 29,48
Capacity	Productive	48%	48%	48%	52%
	Non-Productive	28%	28%	28%	26%
	Available	24%	24%	24%	22%
Finance	Revenue	$1 042 631,00	$ 1 042 631,00	$ 1 177 631,00	$ 1 177 631,00
	Material Cost	$ 399 772,00	$ 399 772,00	$ 455 513,00	$ 466 909,00
	Other Variable Costs	$ 24 991,00	$ 24 991,00	$ 66 000,00	$ 24 844,00
	Fixed Costs	$ 392 089,00	$ 392 089,00	$ 392 089,00	$ 400 756,00
	Profit	$ 225 779,00	$ 225 779,00	$ 264 029,00	$ 285 122,00
	Return on Sales	21,65%	21,65%	22,42%	21,21%

Table 1.5. Examples of value stream reporting (Maskell and Baggaley, 2006)

need to measure performance in three different business standards: production cells (to help workers to complete their daily tasks), value stream performance (with the intention of looking in the right direction) and enterprise/plant levels (to enable authorities to track strategic objectives, usually with a financial focus).

4. Lessons learned from personal know-how with JMP

Implementing LP, per se, is not an easy and rather intimidating task; it is necessary to reach commitment at all levels of the organisation, transparency of information and employee empowerment to ensure its success. Since 1995, the author has received technology transfer from the Japan Productivity Centre for Socio-economic development (JPC) about JMP. Many of the ideas in this section derive from these experiences. In this context, three case studies will be shortly described in order to illustrate the criteria and conditions that could highlight the challenges and obstacles of Lean. The example featured herein provides lessons learned and insights regarding short-term successful results that should lead to a greater supportive position from authority's side. However, despite the positive outcomes obtained, the awareness of the authorities was not satisfactory and, on the contrary, their inconsistent attitude clarifies some difficulties and hurdles that may be the sources of many failures in LP implementation.

4.1. Case A: Technology Transfer of Continuous Improvement for Productivity Culture Development

At the beginning of the 90s, Costa Rica has focused on the industrial progress through human capital development and competitiveness of enterprises. In specific, productivity enhancement was considered as a key role player that contributes to economic growth, developing industries, increasing employment opportunities and improving living standards. As steps unto achieving these goals, a technical

cooperation venture amid Japan and Costa Rican Governments took place. Centred on the aid of the Japan International Cooperation Agency (JICA), the venture was called '*The Technical Instructor and Personnel Training Centre for Industrial Development of Central America in the Republic of Costa Rica*' (CEFOF) and its overall goal was to improve productivity in Small and Medium enterprises [4] in Central America.

Therefore, as part of the technology transfer, JPC and JICA have sent Japanese specialists to work together with Costa Rican's counterparts. Those counterparts were trained by the experts with two techniques: "*Off the Job training*" (Off-JT) (lectures and exercises of solving case studies) and "*On the Job Training*" (OJT) (conducting consulting activities in pilot plants); both forms deliver know-how, meaning that awareness is reached through theory along with practical experiences. CEFOF methodology of transfer of technology to organisations was based upon two ways training by seminars, lectures and workshops and technical assistance to enterprises. The author worked as a counterpart of the production and quality team. A list of the firms that the author has consulted while working for CEFOF is presented in Table 1.6

4.1.1. Productivity Management and Value Added Measurement

As mentioned above in the literature review, decision-makers sometimes have a blurred picture of the overall operational efficiency as a result of a large amount of information combined with poor analysis (Lewis, 2000, Bicheno and Holweg, 2016). The first experiment concerns Fideos Precocidos de Costa Rica S.A., belonging to the food industry and dedicated to the production and distribution of steamed noodles and powdered beverages. The company has contacted CEFOF for technical assistance owing mostly to the higher costs associated with their production process. Over the course of the support provided, after preliminary diagnosis, feedback from the consulting team (expert and counterparts), it became clear that the company had a lot of waste in its manufacturing methods. In this respect, it was noticed that the upper level staff had mainly a short-term view. Their conception about productiveness was purely technical in scope, since it considered financial and operational parameters alone. However, other aspects were also not taken into account, like the human or environmental ones, as opposed to the original thinking brought out by the Japan experts. This is why the first step to be taken was to teach both personnel and managers on what holistic productivity entails, then to introduce 5S to carry out a value-added productivity measurement evaluation.

4.1.2. Kaizen and 5S Activity

Three other cases are also presented in table 1.6: Grupo Comeca, Atlas Eléctrica S.A. and Grupo Irex. They were selected as the first CEFOF pilot plants to introduce both Kaizen and the 5S program in Central America. These companies expected from this technology transfer a greater knowledge on productivity management, but more specifically on the bases given by the methods of continuous improvement in support

[4] Source : https://sites.google.com/site/facilitadoresjica/home/noticias

of the productive process, the increase of their competitiveness and the expansion of their market. Initially, in both Atlas and Irex, the team of consultants found that the authorities' vision of these practices was again too operational and short-term. This was opposed to the considered methodologies; therefore, they have never understood the synergy between social and technical aspects towards a more critical orientation. In contrast, Comeca has introduced the integrated concept of productivity in parallel with 5S. It should be noted that senior management did understand the synergy between the tools and long-term strategy, not only to support other critical aspects of their production (safety and cost reduction), but also to improve their processes, quality of life and competitiveness. As a result of this successful application, they became a good example for CEFOF to the industry. These early experiences have contributed to the spread of the institution's technological transfer capabilities throughout the region (Central America and the Dominican Republic) under the OFF-JT procedure. Some of the companies that have been selected were Purificadora de la Roca, Taller Industrial Antonio and RYO Group of Companies. Nevertheless, according to the consultant team's interpretation, these SMEs' owners have thought that only attending to the workshops and conferences would be able to transfer the behavioural reform immediately and obtain expected benefits.

4.1.3. Inventory Control Management

The following example in Metalin, which is a manufacturer of office furniture and where a consultancy has been carried out under the OJT format. It has dealt with controlling inventory because of a chaotic manner in accounting and handling their stock as well as a lack of production scheduling skills. Consequently, an intensive effort was made so that the output stream could be optimized. Among other things, a variety of tools such as 5S, Kanban, material handling and production scheduling were used. One noteworthy detail to be mentioned is that the Inter-American Development Bank supported an SME program that enabled funding to be available for technical assistance by CEFOF and for the enterprise to become pilot plants. Further, sometime afterwards, once the advisory activity was over and/or a follow-up visit was made, it became clear that there was no genuine commitment from the owners, since the factory was again untidy, which meant that the sense of cultural change did not permeate.

4.1.4. Supervisor's Training Course

An additional illustration came from a "*Supervisors Training Course*" held by CEFOF at Colchonería Industrial Dominicana, responsible for the manufacturing of mattresses, furniture and textiles. After two months, both the expert and his counterparts, who had provided the training, visited the facility. During this monitoring, it was evident how few changes were carried out by the organization. Based on interviews with some managers and middle management, the team concluded that the authorities believed that the behavioural change would be met quickly enough to have a positive impact not only on manufacturing but also on sales. Another observation was that the leaders did not have any competence in quality or production administration.

Tools/ Techniques	Firms	Companies' Main Expectations	Background of Managers	Perception from Managers
Productivity Management, Value Added Measurement	Fideos Precocidos de Costa Rica S.A. [Steamed noodles & powdered drinks]	Knowledge & Profitability	Low know-how of cost reduction, Short-term view	Authorities not at all connected the tools with productivity approach,just with ratios and never with finance indicators
Kaizen & 5S Program	Grupo Comeca, [Corrugated packaging & pulp paper and containers products]	Knowledge & Support to safety plant issues	Lack of know-how on Productivity Management, 5S & Kaizen	The most,successful technology transfer (good example)
	Atlas Eléctrica S.A [Refrigerators; Stoves, washing machines & microwaves]	Improvements to be more competitive (Market expansion)	Lack of know-how on Productivity Management, 5S & Kaizen, Short-term view	Companies have,implemented different tools individually but never saw the interrelationship, between them
	Grupo Irex, [Detergents, cleaning products & processed foods]	Improvements to be more competitive (Market expansion)	Low know-how on Quality management skills. Short-term view	Practices were,successful during initial period (superficial understanding & short-term, viewpoint) due to a wrong application
	Taller Industrial Antonio [Construction of heavy, machinery]	Knowledge & Improve Production Management	Lack of quality & production management skills	Some participants,thought that it requires a lot of efforts, time and budget.
	Purificadora de la Roca. [Processing & marketing of water]	Improve Production Management	Lack of quality & production management skills	Managers &,foremen thought that just by participating in the seminars and courses they,will reach the behaviour change and positive results in short-term
	RYO Corporation [Chemical Specialties]	Knowledge & Competitiveness	Low know-how on Productivity & Quality Management approach	Managers &,foremen thought that just by participating in the seminars and lectures, they will reach the behaviour change and positive results
Inventory Control Management	Metalin S.A, [Office furniture]	Knowledge & Profitability	Lack of production scheduling skills	Top managers,accepted because of funds from International Organisations
Supervisors training course	Colchonería Industrial Dominicana, [Mattresses, furniture & textiles]	Increase Sales & production	Lack of quality & production management skills	Managers &,foremen thought that just by participating in seminars and courses, they will reach the behaviour change and positive results in short-term
5S & Quality Management	Black Orchid Resort	Improve Quality	Lack of quality management skills	Top managers have,attended but just interested in hints of the tools rather than know-how (fashion)
	Kosmoquimica S.A. [Hair, body cosmetics]	Increase Sales & competitiveness	Lack of quality & production management skills	Companies have implemented different tools individually but never saw the interrelationship between them
	Corporación Cefa S.A. [pharmaceutical products]	More profits & competitiveness	Lack of quality & production management skills	Superficial,understanding & short-term viewpoint due to a misconception

Table 1.6. Experience as a CEFOF's counterpart and obstacles observed

4.1.5. Quality Management

To conclude with these syntheses of consultancy experiences, workshops and quality improvement sessions are also shown in Table the table 1.6. Some attendees from companies such as Black Orchid Resort (service sector), Kosmoquímica S.A. (hair and body cosmetics) or Corporación Cefa S.A (pharmaceutical products) have provided information about the antecedents of the directors and the reasons why they have participated, in particular some of the reasons for their presence:

- An interest for hints of the instruments instead of know-how (fashion).
- To receive the didactical material.
- Superficial understanding and short-term viewpoint due to a misconception.
- Lack of skills in quality and production management.
- Companies have implemented different tools individually, but without seeing the interrelationship between them.
- Some authorities thought that it requires a lot of efforts, time and money.

In conclusion, based on these observations, it can be seen that many participants have reduced JMP to a mechanistic, superficial and short-term set of tools, looking forward to "*fast victories*" but not for sustainability through time. Fast results made the managers believe that they had fully understood the methods and philosophy behind Lean. However, the problems arise in the medium term when it is not possible to sustain those positive outcomes over time. There are two insights into the JMP based on lessons learned: the first is to establish an operational roadmap based on solid foundations and the second as an emphasis on the toolbox. At first glance, according to the experts, the strategies articulated suggest synergistic transformations underpinned by a more holistic conception of productivity (as a starting point) coupled with continuous improvement. Such an efficient and effective effort was not limited to a strategic dimension, but required rather a new attitude of doing business, detached both from innovative and complex modes for governance (this productivity-oriented perspective will be discussed in the following chapter). Secondly, if the strategy is focused exclusively as a toolbox, the socio-technical element will not be properly understood, leading to common misconceptions. Each of these propositions will affect how much advancement there is within the implementation pathway and how it has been tackled.

4.2. Case B: Basic Continuous Improvement Strategies for production performance improvement

Intel Costa Rica is a vast Research and Development Centre and one of the most varied and complex Global Services Centres in South America. It started its activities in 1997 with an assembly and testing plant. When Intel wants to allocate new products and projects to its factories, it is done by setting in competition its manufacturing sites located in the Philippines, Malaysia, Ireland and Costa Rica.

4.2.1. 5S Program Implementation

Based on this strong competition between factories of the corporation, the production manager from shift 5 has agreed to implement 5S and Kaizen activities. In a context of defiance of accepting Lean in an initial phase, the emphasis was heavily set on the use of LP tools. Hence, in order to improve shift ratios, 100% back-end workers were trained. This started to have positive impacts on the manufacturing process, such as an enhancement of the employees' discipline, more empowerment and a better image of the Plant during the shift 5. Consequently, production managers from other shifts have decided to implement it as well.

Despite these positive results in shift 5, an overview is given in Table 1.7 showing a snapshot reflecting the background and perception of site heads. During this period, certain situations arose such as a misinterpretation of concepts, short-term viewpoint, the fact that the managers did not participate in activities with the staff (only as spectators), the poor comprehension and application of the tools by not linking the 5S to productivity-enhancing. These reasons have caused the program to fail in other shifts.

In addition, there was already another supplementary programme known as "*Mr. Clean*", without any direct participation from Intel personnel: it was subcontracted and carried out by a provider, who delivered cleaning services to the entire infrastructure. Thus, the simplistic attitude of the leaders had confused them by comparing the 5S with "*Mr. Clean*", which meant that their commitment was fragile. This demonstrated their low competence in the philosophy of continuous improvement.

4.2.2. Kaizen Projects

Another significant achievement in shift 5 was the reduction in rejections (see Table 1.7), linked to continuous improvement activities. Implicitly, applying the different types of Kaizen requires the merging of various practices as quality control tools to solve problems in the process lane. This will be explained in the next chapter.

Again, the production leaders (from other shifts) and their low expertise on how to gather productivity and quality aspects, have made them misguidedly implement different tools individually, without ever link them with the human factor.

Even though, it was established a Kaizen training course at Intel University interface delivered to all the personnel; many managers and supervisors thought that just by participating without concrete tasks, the staff could reach the behaviour change required and that positive results would occur at once.

Tools/ Techniques	Company Expectations	Background of Managers	Perception from Managers
5S Program	To improve shift and Plant ratios	Low know-how of cost reduction, Short-term viewpoint	Authorities not at all connected the tools with productivity approach,just with ratios and never with finance indicators
	To improve the image of the manufacture	Lack of know-how on Productivity Management and 5S.	Production managers did not participate in 5S activities with the employees. Just as spectators.
	To improve housekeeping	Misconceptions of terms 5S and Mr Clean activities	Superficial understanding and short-term viewpoint due to a misconception
Kaizen	To reduce quality rejects	Low know-how of Productivity management and misconception of terms	Managers and foremen thought that just by participating in the training courses the staff will reach the behaviour change with positive results
Problem Solving Techniques	To empower employees	Lack of skills on how to relate the social and technical aspects.	Managers have implemented different tools individually but never link them neither the human aspect
Safety (Prediction of accidents)	Support to safety Plant issues	Misunderstanding of the concept	Managers wanted to implement 6S (to add Safety as one of the "S" of 5S)

Table 1.7. Implemented tools and obstacles observed at the manufacturing plant

4.2.3. 5S Program supporting other projects

At Intel Corporation, safety is one of the most important values. 5S supports very well this policy. Based on this tool, another training course was delivered on "*prediction of accidents*" (Kiken Yoshi, a Japanese methodology); both have worked very well. Another issue is the one related to safety and its bond with 5S; it has become trendy for some businesses to add another "*S*" - suggesting also that Safety could be incorporated as part of the program (Roll, 2008). However, such perception is inaccurate (this will be further detailed in the next chapter) since 5S must support other areas (i.e. production, quality, logistics or maintenance among others) looking forward to improve productivity. Table 1.7 shows that the production managers wanted to change from 5 to 6 "*S*" (in order to include safety) due to their scarcity of knowledge and commitment regarding the subject.

In summary, boosting productivity initiatives have failed at Intel because of the lack of encouragement and the short-term standpoint of the factory authorities. The relevance of directors to be supportive of those sociotechnical aspects and to challenge the people continuously to enhance is a key to advocate commitment.

4.3. Case C: Basic Continuous Improvement for Factory competitiveness improvement

Holcim is one of the world's foremost suppliers of cement, aggregates and ready-mix. By then, the headquarters has been encouraging the development of "*World Class*

Maintenance" (WCM) to ensure its competitive positioning, the lowering of costs and the upholding of global standards. Given this pressure from the central office, the director of the Costa Rica manufacturing plant has had serious preoccupations regarding the enthusiasm of the personnel towards the WCM application process.

The experience at this cement plant can be divided into two phases; the first was the start-up of a Productivity management methodology. Under this context, the former head of the organisation has agreed to apply the Productivity Integrated Approach based on Practical Kaizen, Quality Control Tools and 5S activities in order to improve the production, maintenance and safety indicators (i.e. Overall Equipment Efficiency - OEE - and Mean Time Between Failures - MTBF - or Safety frequency index). In the second phase, the effort declination period described in Table 1.8 explains the circumstances under which these tools were implemented and some general obstacles perceived from the new authorities at that time.

Tools/ Techniques	Company Expectations	Background of Managers	Perception from Managers
Productivity Management & 5S Program	To improve factory image with Headquarters	Misconception and low 5S & Kaizen skills	The continuation of Kaizen and 5S actions have left behind because another Factory's Manager came with less support of the activities
Seiso inspection activity	To support the WCM approach	Misreading of the overall understanding of the concepts and how 5S support maintenance	The new Plant Manager has decided to continue just with those activities related to maintenance
Kaizen & problem solving techniques	To improve manufacture ratios (OEE, MTBF)	Lack of knowledge of the concept	The budget for the continuation of the 5S and Kaizen activities were cut down by new authorities.
Safety (Prediction of accidents)	To improve safety	Misunderstanding of the concept	New plant managers were focused on the production of clinker

Table 1.8. Continuous Improvement practices and obstacles at the Cement Plant

4.3.1. 5S Program application

Due to pressure from the Head Company to optimise the WCM performance of the cement plant, the 5S programme was implemented, initially, to improve the image of the factory while also backing up other areas of the value chain (as noted before). At the beginning, the leaders just have heard about JMP in general terms, even though they decided to support the initiative with full commitment, especially the former plant manager.

Then, positive results started to come up; for instance, 100% of the personnel was trained, 500 tons of garbage and waste were eliminated, a visual factory was applied in order to foster safe, clean and better-organised atmosphere but especially the empowerment of the staff. Figure 1.5 shows an example of a Big Cleaning Day. It can be seen the evolution of the work at the belt conveyor during the application of 5S activity in the mining process.

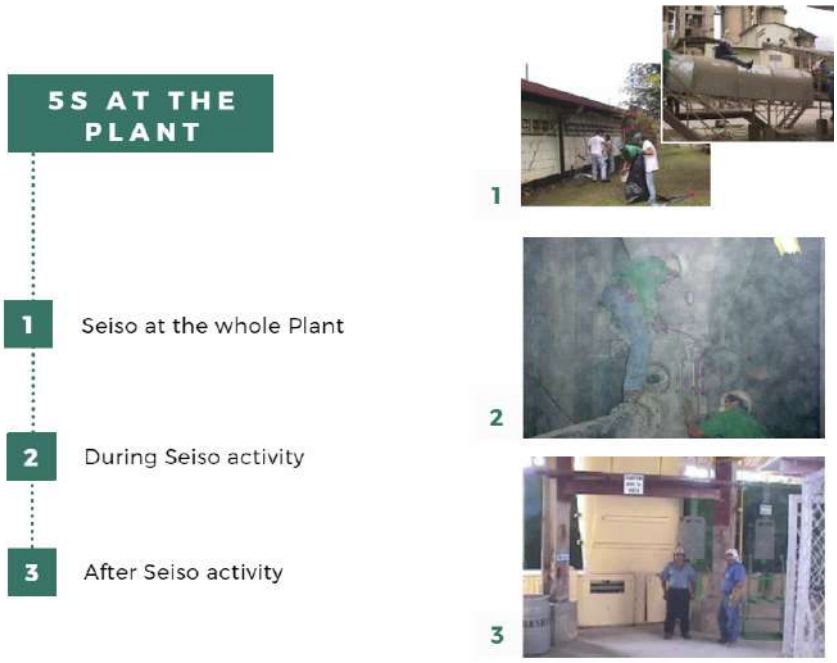

Figure 1.5. Example of 5S activity at the cement plant

4.3.2. Kaizen Projects with positive impacts on the production plant

A firm's proficiency to assimilate, adjust and update its socio-technical advantages steadily is a key to be competitive. All these results underline the synergy between practices and employees (sociotechnical aspects), so their influence will directly affect over the organisational performance.

Once 5S was applied, it has been complemented with a Kaizen philosophy, in order to improve maintenance ratios (OEE, MTBF). For example, one of the proposals of cost reduction in the clinker process made savings of approximately $10000/year on the electrical consumption of the cement plant and by that improved the firm's finances. Another Kaizen by analysis[5] has made the MTBF increase from 25 to 80 hours at the ball mill, reducing the stoppages and resulting in a considerable amount of savings on that process.

[5]This is one of the types of Kaizen; it will be discussed in greater length on the next chapter.

4.3.3. Productivity Management bearing different domains

Ohno (2012) has taught the "*workplace oriented focus*", or "*Gen principles*" (clarified in the next chapter), whereby a persistent encouragement of all types of waste reduction (concepts that will theoretically be clarified in the next chapter) is given to capture how relevant it is to cut down costs and the consequent profits. Thus, an objective of any JMP should be amplified to extrapolate efforts from a tool-orientated focus to a critical problem-oriented one. By this, it is meant an attempt by all those who are involved within the value chain to find difficulties and to constantly optimise it, thereby helping other areas such as production, maintenance, quality, etc.

To illustrate this point, Figure 1.6 exemplifies this emphasis on the most critical issue; here the objective was that 5S programme be used to back up autonomous maintenance endeavours under the TPM strategy. In the course of an activity within the programme known as "*Seiso Inspection*", some wastes were discovered. Subsequently, corrective and preventive actions were established which resulted both in a reduction in pollution levels at the Pallet Centre as well as a drop in product rejection rates.

Figure 1.6. Wastes recorded in a 5S event called "*Seiso Inspection*" at the Dispatch site

Additional examples of Kaizen being applied and supportive into other fields such as work environment and safety are the Kiken Yoshi (accident prediction) training, which has enabled an enhanced frequency index (telling the number of accidents per million hours worked) of the plant. Accordingly, derived from these positive results, an explanation was made in the Holcim's Training Forum in Switzerland with the participation of plant managers all over the Holcim World.

4.3.4. Obstacles for continuous improvement initiatives

In spite of the accomplishments obtained from these practices, many obstacles appeared as well and the continuation of Kaizen and 5S were left behind due to a change of the manager. Some obstacles encountered at the cement plant may be found in Table 1.8; in particular, the headquarters has taken the decision to carry out a full-scale reengineering plan, with the replacement of the plant Director along with a significant reduction on the budget. Derived from a request from senior office, this new leader's sense of emergency was driven to increase manufacturing performance, foremost in maintenance rates. Nevertheless, the new authority's lack of continuous improvement knowledge and the false impression about those concepts have made that the sequel of Kaizen and 5S have collapsed. Under those circumstances, the Director decided to keep only the maintenance activities related to the production of clinker, so the support and commitment of those strategies were weak until it almost vanished. Latterly, Holcim Costa Rica left the WCM initiative and the attention now relies on Lean.

Again, these practices have revealed hurdles while implementing managerial methodologies such as short-term viewpoint; deficiency of knowledge from the directors, so implicitly the lack of engagement the philosophical understanding of JMP and principles. Summarising, these experiences disclosed once more that the leader support has affected both positively and negatively every implementation process and specifically the organisational commitment, sociotechnical factors and metrics.

5. Conclusion

This chapter has attempted to provide a theoretical and practical framework that positions the concepts and hypothesis underlying this research work. The state of the art is summarized in Figure 1.7, centred on twofold specific elements: the authors' know-how on Japanese Management Practices being applied to businesses and the literature reviewed which has given insights into the circumstances surrounding Lean development. As a conclusion, Lean's scope has often been mislaid as a mere "*toolbox*", with a significant influence upon how it is applied. Thus, to understand why LP implementation often fails, we suggest two simple reasons: firstly, the corporate culture and, secondly, how the business has been managed from a top-down perspective. Indeed, the body of knowledge provides an inside look at the Lean's obstacles, referred to in this research as "*management issues*". According to this angle of view, these difficulties are classified into three factors: commitment of the authorities, socio-technical and metrics.

In conclusion, the final objective of Lean is to aware firms over the need to change their organisational model into a more competitive and profitable one. This transformation means better understanding of the culture in which the company has been involved. To accomplish this managerial mind-set, our assumption is to recognise LP as a long-term business strategic approach.

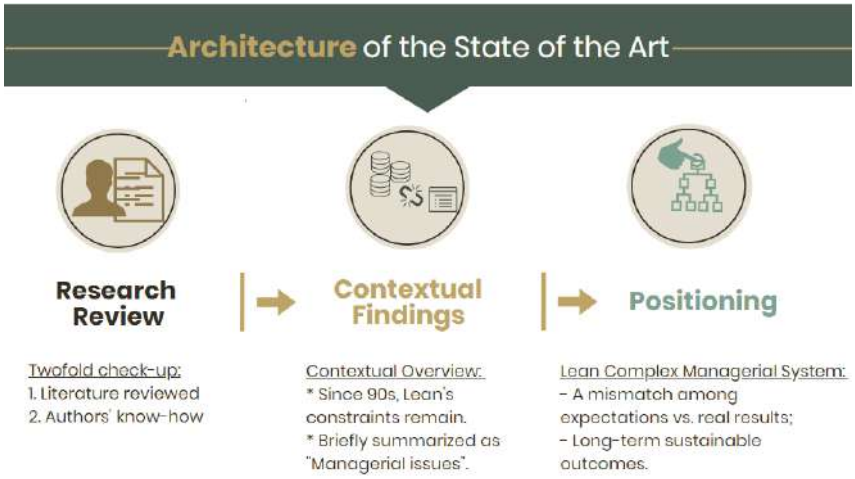

Figure 1.7. General Context and Findings Scheme

In the next chapter, what will be underlined is some pragmatic evidence behind the assumption of Lean as a dynamic and complex system. Furthermore, its strategy will be positioned as changing organisational behaviour based on clear and interconnected socio-technical principles.

For that reason, enhancing the methods can be critical in dealing with Lean; thus, productivity has had a significant impact on raising awareness and proficiency and to support staff involved in continuous improvement initiatives that add value to the customer and eliminate waste within their organisations. Until now, few authors have tackled the amalgamation of the business management practices and its bond with productivity (Birdi et al., 2008, Scherrer-Rathje et al., 2009, Gunasekaran and Ngai, 2012). Consequently, a crucial role is played by the productivity holistic approach as a "driver of organisational change" that might help to solve all the management issues founded in the literature review.

Additionally, profitability and productivity are key players for structuring a Lean system that responds to market requirements through an emphasis on quality, cost and delivery.

Chapter 2

Evolution process and evaluation of the Lean deployment framework.

Contents

1. Introduction

In the first chapter, it was shown that globalization has brought new challenges and evolving market conditions. These circumstances have led companies to change drastically their operating patterns, thereby gaining significant competitive advantages and boosting their performance (Porter, 1996, Emiliani and Stec, 2005). Many experts have proposed different stewardship initiatives, e.g. Lean, which methods incorporate an articulated set of principles, practices and instruments that provide guidance and support to monitor and improve the business (Liker, 2005, Bicheno and Holweg, 2016). All these frameworks require a complete mental overhaul across the organization to become competitive and thrive in the current "*information era*" (Senge, 1991, Carder and Monda, 2013).

This chapter gives some reflections on the inconsistencies that have been found to date between the main objectives of Lean and the expected results due to the management constraints mentioned in the previous chapter. In section 3, we shall discuss features that have hampered technology transfer from Japan to the rest of the world. In Section 4, we develop our vision of Lean as a business strategy, while Section 5 shows how crucial the concept of holistic productivity, lost during US benchmarking, is. Section 6 deals with Kaizen in terms of its significance for productivity. Section 7 focusses specifically on results measurement and their implications for Lean; finally, section 8 presents an overview of the complexity involved in this business management strategy.

2. Summary of the inconsistencies

Figure 2.1 depicts the general situation surrounding Lean development, which divides time into three major intervals. The first one is the birth of the concept (the post-war period) in which the government, through the Japan Productivity Centre (JPC), has enacted productivity movement policies geared towards revitalizing its industries. From there arose the Japan Management Practices - JMP (TQM, TPM and JIT) promoting the competitiveness of Japanese companies; such is the case of Toyota. Afterwards happened the "*Benchmarking*" phase, when US scholars undertook a Toyota Production System (TPS) survey. However, this Japanese technology was transferred to the rest of the world with some interpretation biases (see B1 part in the figure above). Over the years, Lean Practices (LP) have been designated as a revamped version of TPS (Schonberger, 2007, Taylor et al., 2013). Yet, there is still a huge disparity between the original concepts and practices developed in Japan compared to those interpreted by occidental theorists (Hines et al., 2004, Emiliani and Stec, 2005).

It is the author's opinion that Lean introduction has faced recurrent difficulties since the 90s (see B2 part of figure 2.1). Undoubtedly, a fragile conceptual basis could drive a poor reappraisal of any governance strategy, including wasted resources or even discouraged workers (Holweg, 2007, Joosten et al., 2009, Losonci et al., 2011).

A "thin" process of technological transfer of knowledge causes this breach (Lillrank, 1995). Hence, beginning with this investigation, several hypotheses emerge. Some Lean findings and their origins are explored in detail in the following sections, beginning with the challenges of knowledge transfer.

Figure 2.1. General Scheme of the Thesis.

3. Challenges of Knowledge Transfer

In most of the literature, it is admitted that Nippon innovative style of administration for competitiveness has had a profound influence on current management thinking (Gilbert, 1990, Shah and Ward, 2003, Atkinson, 2010). The flow of these new frameworks has come from Japan to the United States since the 70s (Schonberger, 2007). In the case of Europe, its footprint occurred much later and was largely filtered out in accordance with American interpretation (Štrach and Everett, 2006, Taylor et al., 2013). This indirect diffusion has led to some misunderstandings of the manipulated concepts.

Knowledge transfer is hard to perform, needs to be culturally adapted (Holweg, 2007) and, besides, Japanese is a language that depends heavily on context (Ohno, 2012). Susuki (1993), for instance, asserted, "*Many managers and employees have studied the Japanese management and various productivity tools... Depending on how they are used, the same tools can produce extremely different results. A cooking knife used incorrectly can kill a person*". In most cases, the westbound benchmarking process has been marked by a fall in the expected results of Lean. It is undoubtedly tied to an inaccurate and "*light*" interpretation of the underlying concepts (Hampson, 1999, Haghirian, 2010, Schmidt, 2011).

As a summary, Table 2.1 provides comparisons of differences between the original "*know-how*" whose symbiosis strengthens JMP and those distilled by the North Americans who handle themselves individually. Under these circumstances, it becomes necessary to go further and establish hypotheses, then validate them, to clarify such inconsistencies and resolve them through a more holistic reasoning (Kasser, 2015) that will allow to find out the true essence of learning behaviour change approaches such as TPS, TPM or TQM, predecessors of Lean (Štrach and Everett, 2006, Schonberger, 2007, Taylor et al., 2013). Additionally, from a business standpoint, typically in a learning organization, it encourages a problem-solving atmosphere; which is intended to discover the incompatibility between the current or real situation and the expected potential output of the production process. (Birdi et al., 2008, Dombrowski and Mielke, 2014).

Concept /Tool /Technique		After 1950 Productivity Approach (JIT/TQM/TPM)		1990 - present Lean	
		Original Definition	References	Concept filtered definition - APICS	References
Foundation	Productivity	"The productivity is, above all, an attitude of the mind. One can make the things better today that yesterday. It believes on the progress of the human being"	(1), (2), (3), (4), (5), (7), (8), (9)	6.11.1 Productivity is the overall measure of the ability to produce a good or a service. It is found by comparing actual output of production to actual input of resources...	(20), (21), (22), (23), (24), (25), (26), (28)
	5S Program	Participation Program for small group activities. Look forward to,Productivity and work environment improvement.	(4), (5), (6), (10), (11), (12), (13), (14), (15)	3.11.5 Five terms beginning with S used in creating a workplace suitable for lean production.	(6), (11), (13), (16), (28), (29
	Kaizen	Japanese concept for Small Changes but continuous (spiral PDCA). It is a concept, or state of mind, oriented toward continuous improvement.	(4), (5), (6), (10), (14), (15), (18)	3.11.7 Japanese term for improvement. Is continuing improvement involving everyone - both managers and workers. In manufacturing, kaizen is finding and eliminating waste in machinery, labour and production methods	(16), (28)
	QC tools	They are basic tools for Quality Control of processes used to analyze data and problem solving.	(3), (4), (5)	4.4.4.1 Quality Improvement tools: 95% of all quality issues in the factory can be solved with 7 fundamental quality tools: check sheets, histograms, flow - pareto and control charts, cause and effect and scatter diagrams.	(28)
	Suggestion Scheme System	It is an employee involvement method taps their knowledge for ideas for improvement.	(4), (5), (9)	The concept is not defined in the APICS dictionary	
	Quality Control Circles	Small group of employees who collectively solve problems contenu..., have been a popular employee-involvement technique...pursuing excellence...	(4), (5), (6), (9)	The concept is not defined in the APICS dictionary. A group of employees from the same work unit to solve work-related problems	(30)
Lean concepts	Value Added	Value added is commonly used in measures of an organisation's productivity, as it represents the wealth created through its production or services process.	(4), (16), (17), (19)	2.4.2.1 Value creation is taking raw materials or knowledge and converting it into a product or service that has more value to the customer than the original material or data. Value is created using transformational processes.	(28)
	Waste	It is a non productive activity that does not add value to the originals materials, parts, products or information. Basic type (3K): Kuraii, Kitanai, Kurushii. Production type (3Mu) : Muri, Mura, Muda. Maintenance type: 6 Big Losses	(4), (16), (20)	3.11.3 ... waste is identified by the Japanese word muda. There are 7 categories of waste:overproduction, waiting, transportation, processing, movement, inventory, defective units, reworking products and components.	(16), (28)

(1) Hutton (1958); (2) Drucker (1971); (3) Japan Productivity Centre (1988); (4) Fukuda and Sase (1994); (5) Susuki (1993); (6) Nakane and Hall (2002); (7) Stainer (1995); (8) Sunaga (2006) ;(9) APO (2015); (10) Tsuchiya (1998); (11) Schonberger (2007); (12) Kobayashi et al. (2008), (13) Gapp et al.(2008), (14) Ohno (2012), (15) Takemura (2016); (16) Emiliani and Stec (2005), (17) Spring Singapore (2011); (18) Rüttimann and Stöckli 2016; (19) Shimizu (1991); (20) Stainer (1995); (21) Bloom, Nicholas and Van Reenen (2011); (22) Coelli et al. (2005); (23) Tangen (2002), (24) Office National Statistics (2007), (25) Bloom and Van Reenen (2007), (26) Syverson (2010), (28) Castle and Jacobs (2011); (29) Hines et al.; (30) Lillrank (1995)

Table 2.1. Discrepancies between original and filtered concepts

Lillrank (1995) has offered an interesting explanation for these transferral problems thanks to the analogy with "*The High Voltage Electrical Transmission*". He explained that power losses are dependent on how voltage and distance relate. At this point, electrical current is transferred at high voltage over long distances, so that resistance can be reduced and reach an appropriate usable level. When the distance is known, the optimum voltage can therefore be established.

Schematically, Figure 2.2 illustrates Lillrank's analogy about the whole technological transfer given by Japan, which has travelled long distances (both geographically and mentally). It has experienced a great amount of resistance because of misinterpretations with different and adverse mind patterns (language, history, society and culture). Likewise, during this way of knowledge dissemination, some relevant concepts have been leaked with differences in abstraction levels. This has provoked in turn the loss of basic concepts as well as significant information from the original philosophy (such as models, tools, theories, case studies, etc.). Thereafter, the new technology began to be passed on, but with variations, causing that the knowledge receiver understands it in accordance with its own interpretation. When abstraction changes, its scope becomes altered as well.

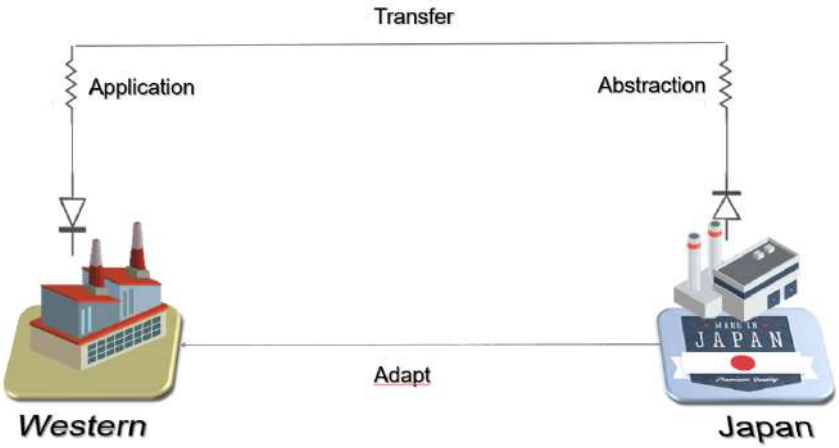

Figure 2.2. The High-voltage Electric Transmission analogy. Source (Lillrank, 1995)

To minimize such miscarriages, a solid comprehension of abstract core notions is a prerequisite, followed with further states (copying, adapting or emulating with innovation). Figure 2.3 has highlighted typologies and channels of abstraction:

- Low abstraction —supply driven [1]: Usually the most frequently used; it describes new trends and practices that emerge without in-depth reflection (e.g. 5S or quality control circles).
- Low abstraction - demand—driven [2]: Used when observing new practices and quickly enforced. For example, the use of slogans may fail to grasp all strategical

[1]People focused on research and building knowledge: the key aspect for them is data availability and a proficiency to define and theorize practices.

[2]People focused on developing solutions: a selective perception makes them sees only what they want to see. Therefore, their evaluation of new ideas are changed or complemented depending on the existing practices results.

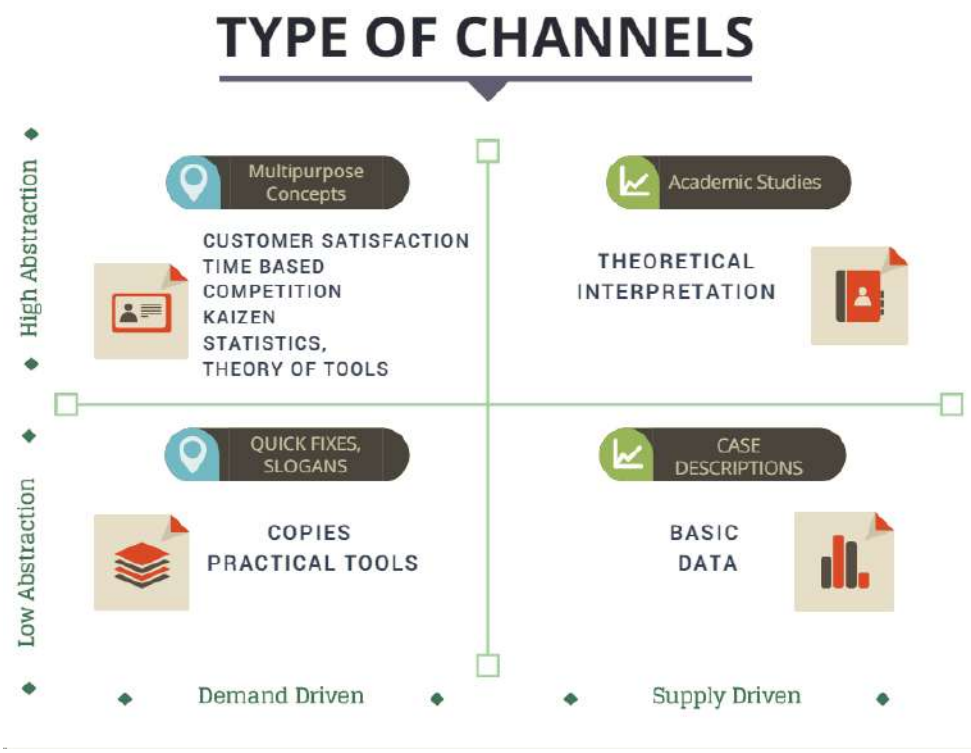

Figure 2.3. Transfer channels types for organisational innovations. Source (Lillrank, 1995)

complexity (e.g. "*zero defects*" or "safety first"). In this case, the "*toolkits*" arise and are usually transferable.

- High abstraction —supply-driven : Usually used by scholars. It rarely attracts the interest of demand-driven performers (organisations, managers and consultants) if low abstraction does not work.
- High abstraction —demand-driven : When the original innovation can have various practical applications, it becomes a general principle (e.g. QC circles practice were merged into Continuous Improvement approach and then western applications started to appear).

Lillrank went on to argue that "*back-to-basics*" has spurred much of Japanese managerial skills. Notwithstanding, the true nature of the Japanese style of administration has not really been grasped and understood by Western scholars (Liker, 1997, Ohno, 2012, Taylor et al., 2013). The major finding from Lillrank's research is the fact that many firms do not properly transfer the source of the original Nippon managerial technology (Hampson, 1999, Schmidt, 2011). Typically, they have emulated these techniques instead of doing intelligent and stimulating learning work for their own organizational approach. To address this, appropriate know-how is required. For example, Ohno (2012) declared that "*Knowledge is something you buy with money. Wisdom is something you acquire by doing*". To be put into practice, in Japan, the learning method is spread in the form of an experience-based teaching experience known as "*On the Job training*", which generates far more than conventional class-based courses (Fukuda and Sase, 1994, Štrach and Everett, 2006). This provides a differentiated panorama

concerning skills building and sharing of meaningful values, attitudes and policies across all spheres of the enterprise and makes it standardized (Lillrank, 1995, Schmidt, 2011).

This kind of reasoning demands a long-term sensitivity and greater attention to experiential pedagogy. Străch and Everett (2006) have endorsed Lillrank's claim that "*assimilation bears on acquiring knowledge from outside of the organization, while dissemination refers to knowledge passing from the organization into its external environment. Assimilation is more prevalent at Japanese enterprises, while western companies are more inclined toward dissemination*".

They continue by explaining that "*Articulation creates a potential for knowledge to be transmitted. Internalization means experiencing the articulated knowledge in its unconscious form, essentially altering the knowledge from explicit to implicit. While articulation is stressed in western firms, internalization is prevalent in Japanese companies*". Henceforward, knowledge transfer is a key aspect of business performance in the global arena (Štrach and Everett, 2006, Schmidt, 2011). From that point on, the next premise appears:

Hypothesis 1: **The JMP was not captured properly due to a knowledge transfer bias during the US comparative assessment impacting Lean performance**.

Lean's unsuccessful expected results can be considered the fruit of a complex organizational innovation driven by a simple / low-abstraction transfer channel heading up a world ruled by very different business paradigms and tenets (Lillrank, 1995). About it, Souichiro Honda argued that "*Action without philosophy is a lethal weapon; philosophy without action is meaningless...Just to be hard working has no value. Rather, working hard in the wrong way is worse than laziness. The right theory is the necessary premise for working hard*" (Asian Productivity Organisation, 2014).

Therefore, Figure 2.4 graphically indicates that, by investigating underlying and important JMP concepts and objectives, it has been possible to establish some locks around Lean over time. In attempting to remove such barriers, the original objectives of introducing Lean can be defined. In addition, it properly redirects the Japanese benchmarking and mitigates the burden of management bias mentioned in the previous chapter.

4. Is Lean a set of tools alone or a strategy for competitive advantage?

As already mentioned, business theories - either TQM, JIT/Lean, Agility or TPM - have been conducted over the years seeking to boost corporate performance (Schonberger, 2007, Bonavia and Marin-Garcia, 2011, Furlan et al., 2011). They are all geared towards a completely innovative style to tackle competitiveness. Indirectly, they have been drawn up on the lines of a "*learning organisation strategy*" building on the skills obtained by employees' Kaizen activities (Lillrank, 1995, Emiliani, 2000, Štrach and Everett, 2006).

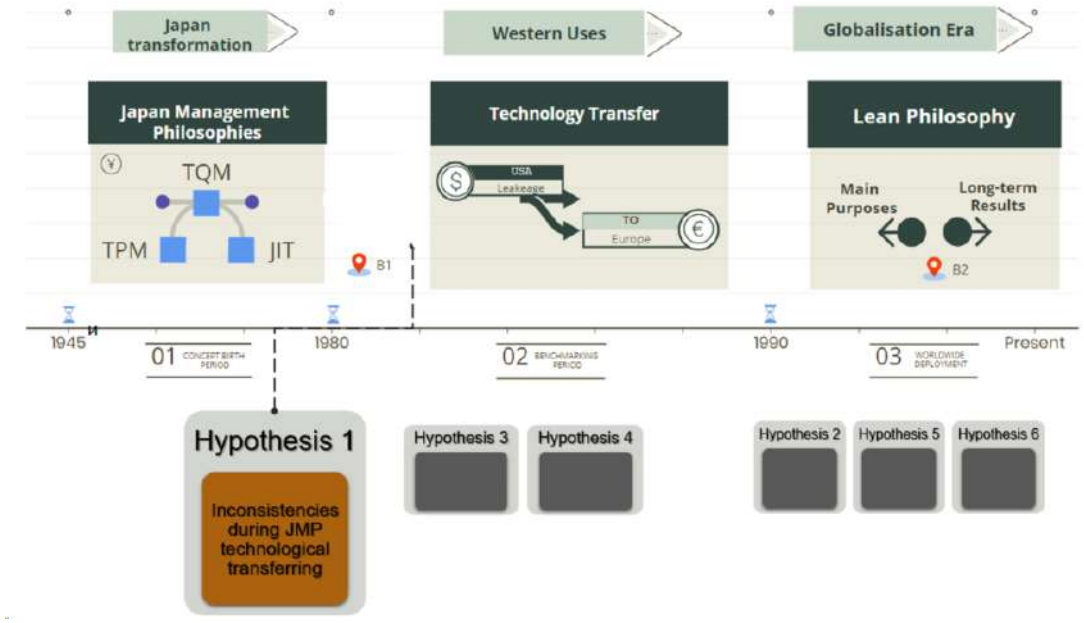

Figure 2.4. Knowledge Transfer Bias of the JMP

Even though the original intent of these methods is meant to be a behavioural change strategy (as explained in section 4.2), companies often demand "*fast-track victories*". Accordingly, there has been a tendency to pay too strong an attention on usage of Value stream tools for Lean support rather than the strategical aspect (Schonberger, 2007, Bicheno and Holweg, 2016). Moreover, this situation is likely to happen owing to wide-ranging techniques and procedures available and provided by numerous handbooks on the subject; evidently, creating an optical illusion about LP towards the "*instrument package*" (Bhasin, 2012, Halling and Wijk, 2013, Lodgaard et al., 2016).

4.1. Beyond the persistent pattern of operational efficiency given to Lean

It is common to consider that the performance of Lean is closely related to operational efficiency in its managerial sense. Consequently, Lean has been viewed as a mean of reaching this objective and its techniques are generally a dependent variable for achieving the expected return on investment (Fullerton et al., 2014, Mourtzis et al., 2016, Galichet, 2018). However, as mentioned before, due to an absence of proper and in-depth acquaintance with this matter together with impatience to obtain immediate results, firms have made obvious that the introduction of the methodology has become a standardized "*recipe*" to optimize their operational performance - production possibilities, cost efficiencies, scheduling, charting, etc.- (Atkinson, 2010, Rüttimann and Stöckli, 2016). Therefore, there are reasons to consider that Lean should rather be seen as a strategy.

Then, in an attempt to dig a little deeper into this issue at hand, specialists have essentially emphasized the two components that characterize Lean: delivering value to clients and reducing waste (Womack and Jones, 2010, Dombrowski and Mielke,

2014, Mourtzis et al., 2016). Now then, concerning "*value*", Hines et al. (2004) have emphasized the need to establish a client-oriented context, under which the cost-value critical balance shall be targeted. In this regard, Ohno (2012) has insisted on the relevancy of cutting costs, "*... do not confuse value with price. When a customer buys a product, he does so because that product has a certain value to him. The cost is up; so you raise your price! Do not take such an easy way out. It cannot be done. If you raise your price but the value remains the same, you will quickly lose your customer*". He gave a clear picture of this by using the formulas shown in Figure 2.5.

The first scenario of this reduction of costs design corresponds to the traditional treatment of revenues, whose predominant claim is to increase the selling price, but this is not within the business hands but rather a marketing function.

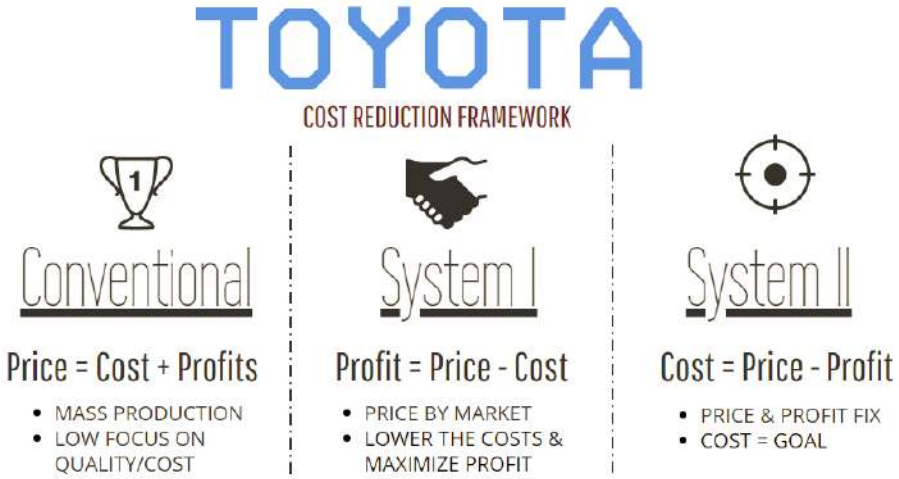

Figure 2.5. Cost reduction framework (Ohno, 2012)

The second equation is about generating profits through efforts aiming at increase the difference between the selling price and the cost. APICS, in section 2.4.2.1, has pointed out that profit is the most significant measure of business success. In the latter formula, JMP was able to confirm the key role played by quality relative to "*value*", as the price of commercialization is automatically influenced by consumers (Mourtzis et al., 2016). This reasoning would suggest that costs should be decreased, entailing a sustained cost-control effort (Porter and Michael, 2001, Ohno, 2012). "*Waste*" contribute greatly towards the rationalisation of costs due to resource consumption. Figure 2.6 features a random manufacturing procedure in which, by operation, it is possible to pinpoint the kind of "*Muda*" that each activity could have. Consequently, it is obligatory to count on a highly committed workforce to monitor all wastes (Hirano, 2009).

Meanwhile, APICS, in section 3.11.3, underlines that "*Lean management is closely related to the concepts of the Toyota production system (TPS). It is applied not only in production but across the entire enterprise, and it has broad applications in the service industries. Lean management involves the systematic identification and elimination of waste throughout the entire value stream. In the TPS, waste is identified by the Japanese word "Muda". The key points distinguishing Lean from other management concepts is the broadening of the definition of waste to include time and inventory. Throughout this, Lean production tends to evolve quickly into continuous flow, utilising little or no work-in-process inventory and*

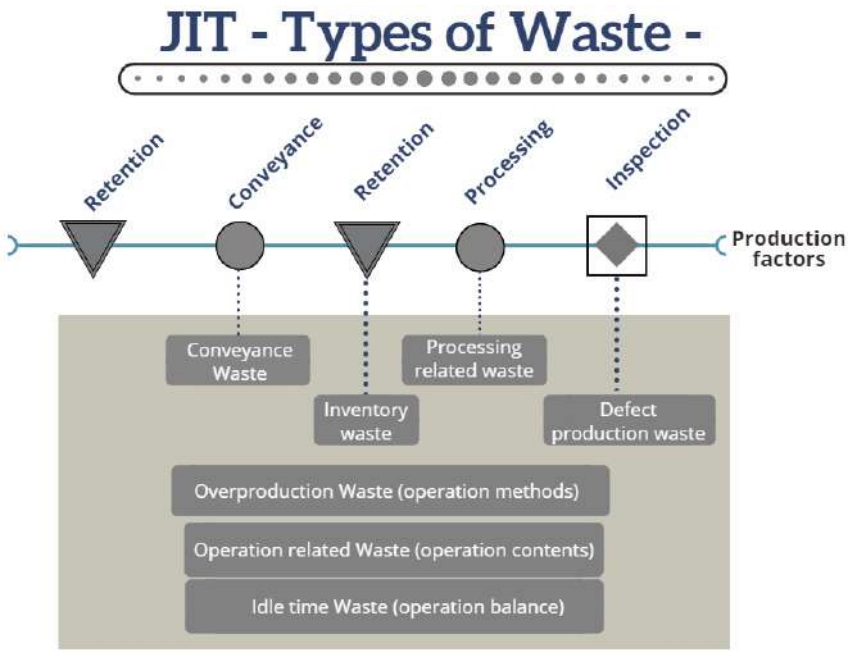

Figure 2.6. Types of Muda by production factors (Hirano, 2009)

ultimately reaching the goal of one-piece flow of the product or service. There are seven categories of waste: overproduction - waiting - transportation - processing - movement - inventory - defective units - reworking products and components" (Castle and Jacobs, 2011).

Following Lillrank's (1995) categorization, the APICS description might be ranked as "*low abstraction-demand*", in which case premise 1 on difficulties of Knowledge Transferral would be reinforced. For the author, in this APICS' statement, two incorrect interpretative trends are shown:

- The prominence APICS places exclusively on Lean practices (that reflects the position taken by many firms nowadays) with no consideration of other factors.
- The imprecise perception of APICS to associate waste exclusively with Muda (shared by multiple publications) (Melton, 2005, Schmidt, 2011, Susilawati et al., 2015).

In contrast, other reference sources have extended the range of waste to two other categories: MURI - overload – when the process (workers or machines) are pushed beyond their capability or demand and MURA – inconsistencies - as a result of fluctuations (below capacity) that hides where losses are and how they occur within the process (Hirano, 2009, Bicheno and Holweg, 2016, Katayama, 2017). Going further, other related concepts worth being mentioned, such as the three elementary wastes (3K): Kurai - dark places, Kitanai - dirty places - and Kiken - hard or dangerous work (Murata and Katayama, 2010), that the 5S program application could remove. In terms of maintenance, the Japanese Plant Maintenance Institute has classified another type as "*6 Great Losses*" as follows (Katayama, 2017):

- Breakdown/failure: losses owing to failure some include erratic function stopping and function reducing in which the equipment yield drops.
- Reduced speed: due to differences between the actual operating speed and the planned speed of the equipment
- Set-up and adjustment: stoppage losses because of set-up changeovers; too much shutdown time spent to machine?s changeovers.
- Defect and rework: it creates losses in resources (volume or time) due to bad quality.
- Start-up or Yield: losses during the equipment start-up until running in and production processing conditions stabilize.
- Idling and minor stoppages: frequent stops or idles due to simple and temporary problems.

Nowadays, many companies feel mainly concerned by the technical side (Shah et al., 2008, Atkinson, 2010). This has led them to the wrong image over LP where human resources continue to be treated as adjustment variables instead as central factor (de Menezes et al., 2010, Fullerton et al., 2014).

About this, Pavnaskar et al. (2003) said that "*Applying tools and metrics is difficult due to a lack of a systematic classification of their applications... The misapplication of a Lean manufacturing tool may result in the additional wastage of resources such as time and money*". Some examples can be mentioned here: dangerous and unhealthy job (Muri), or Mura when having a quality program whose variability is high, or to execute a 5S program only considering it as housekeeping that would be a waste, since its true potential is undermined (Tsuchiya, 1998, Hirano, 2009, Katayama, 2017). In their research, Pavnaskar et al. (2003) have shown how companies often struggle with misapplications of tools and techniques in their quest to become lean. For this reason, they have grouped these deficient implementations of methods into three classes:

- use of the wrong instrument to solve a problem,
- a tool to solve all problems,
- the same application for each problem.

On this basis, they have proposed a structure that logically classifies and organizes 101 methods within a degree of abstraction and binds together each item in those levels. Their study has offered an interesting guidance on solutions about the type of waste that will combat such a tool or where and when to implement it. Nevertheless, their proposal was not joined to other critical factors such as culture, human, organizational or strategic. In support of this critique, the survey by Lodgaard et al. (2016) showed that many employees were not aware about Lean, so they were not sure on what to expect from it or how those practices would support them in their daily work. Experts have demonstrated the relevance of any JMP lies upon "*respect*" for human beings (Bhasin,

2012, Almeida Marodin and Saurin, 2015). Besides, their conclusions have not been validated so far in a manufacturing situation.

To summarize, in different organizations, the current effort given to Lean has been predominantly directed on operational effectiveness (Furlan et al., 2011, Lodgaard et al., 2016). Additionally, such a methodological perception has ceased to be valid, as it is insufficient in terms of disseminating its principles (Schonberger, 2007, Halling and Wijk, 2013). A purely technical emphasis indicates an overly simplistic vision of LP in conjunction with deficient "*know-how*" (knowledge and experience). This would entail a variety of ways to implement it with stagnant results (Taylor et al., 2013, Halling and Wijk, 2013). With this, corporations could be squandering competitive advantages due to scarcity of skills and resources, higher strategic priorities and lack of possible responses to global trends (Joosten et al., 2009, Halling and Wijk, 2013). In contrast, the original JMP approach has defined and identified specific and long-term components (Shah and Ward, 2007), always considering a dual relationship - both technical and social - as an organizational strategy to improve economic, social and even environmental performance (Worley and Doolen, 2006, Birdi et al., 2008, Taylor et al., 2013).

4.2. Lean's Value Chain – Towards a Competitive Advantage

As for Lean, a lot of articles has criticized the fact that despite most scholars and practitioners claim it is not a set of tools, in reality they have addressed it in a purely technical sense (Emiliani, 2000, Joosten et al., 2009). Porter (1996) has stated that "*Operational effectiveness is necessary to compete but not sufficient to win. A company can outperform others and win only if it can establish a difference that it can sustain – a differential competitive advantage... Operational effectiveness means doing things better than competitors, strategic positioning means doing things different from competitors and having better products and services*". The first post - operational effectiveness view - ignores this statement - strategic positioning - since for Porter et al. (2001) the root cause of the concern is to distinguish operational effectiveness from strategy.

Porter (1996) goes on saying that "*Profitability still counts. To compete, companies must operate at a lower cost and/or command a premium price, either through operational effectiveness or by creating unique value for customers*". Indeed, Porter et al. (2001) argue that "*economic value for a company is nothing more than the gap between price and cost and it is reliably measure only by sustain profitability*". This statement shows that in a large number of businesses there is incompetence to exchange revenues for sustainable profitability (Emiliani, 2000, Ohno, 2012). Thus, the creation of true economic value entails that this technical scope triggers further dynamics, i.e. a complement at the social level (Hines et al., 2004, Joosten et al., 2009, Bhasin, 2012). Yet, Porter (1996) defined the strategy as a transcendental vehicle amongst organisations in choosing models that differ from competitors that maximize performance. Hence, duality of Lean is presumed to be seen as a strategy for behavioural and organizational change that precedes toolboxes (Atkinson, 2010, Halling and Wijk, 2013, Bicheno and Holweg, 2016). From this socio-technical aspect, Lean encompasses a competitive advantage endured via organizational innovation with a profound consciousness and engagement, particularly in decision-making (Hines et al., 2004, Lodgaard et al., 2016).

Nonetheless, many people do not notice the drastic and inherent turnaround in how they operate (Hines et al., 2004, Murata and Katayama, 2010, Bicheno and Holweg, 2016). It directly affects the overall business through all functional areas (manufacturing, sales, human resources, finance, purchasing, maintenance, etc.) to meet its goals (Ohno, 2012, Bicheno and Holweg, 2016).

As an example, in Figure 2.7, Hirano (2009) outlines the original cost reduction strategy adopted by many Japanese manufactures with well-known continuous improvement models. It also exhibits a demand oriented market (customer value) and the relationship to workers (responsible for reducing waste). Meanwhile, such transformation includes leadership with the potential to handle change, encompassing behavioural, emotional and political dimensions and not a value stream tooling alone (Lewis, 2000, Birdi et al., 2008, Atkinson, 2010).

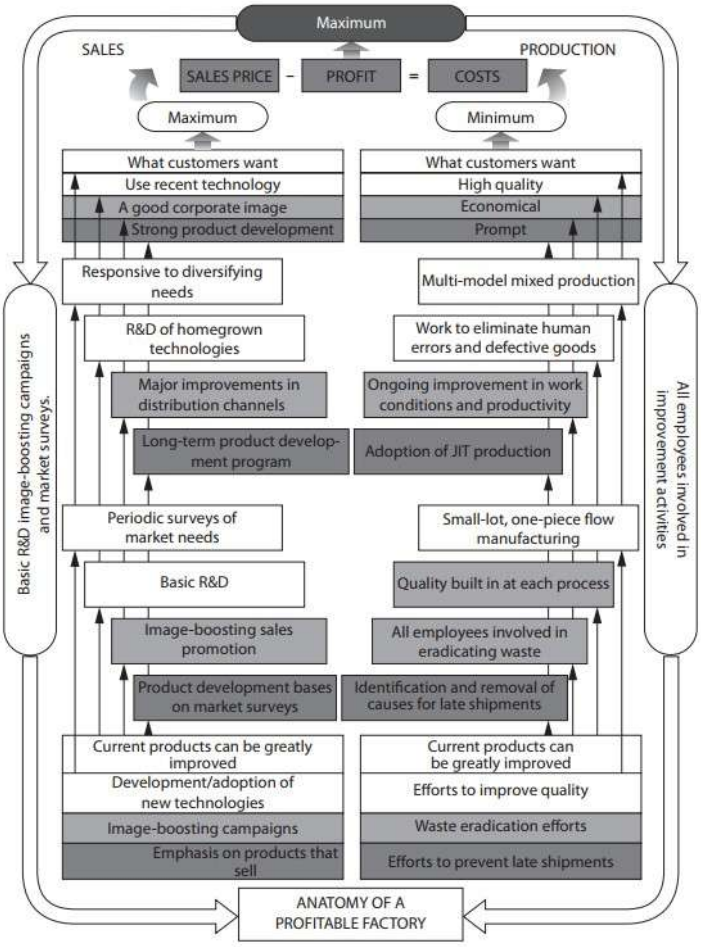

Figure 2.7. Original Outline on Cost Reduction Strategy (Hirano, 2009)

In Figure 2.8, Hirano (2009) has highlighted the sequential milestones for a people-based JIT strategy. This is consistent because all employees are liable to execute new functions, confront diverse achievement criteria and determine real technical consequences (Birdi et al., 2008, Joosten et al., 2009, Bhasin, 2012). New post-JMP systems, such as Lean, have often amended the information into knowledge, spread it across the system, and been affected through its transferring process (Lillrank, 1995, Štrach and Everett, 2006). The Nippon style has directed its philosophy onto a cultural

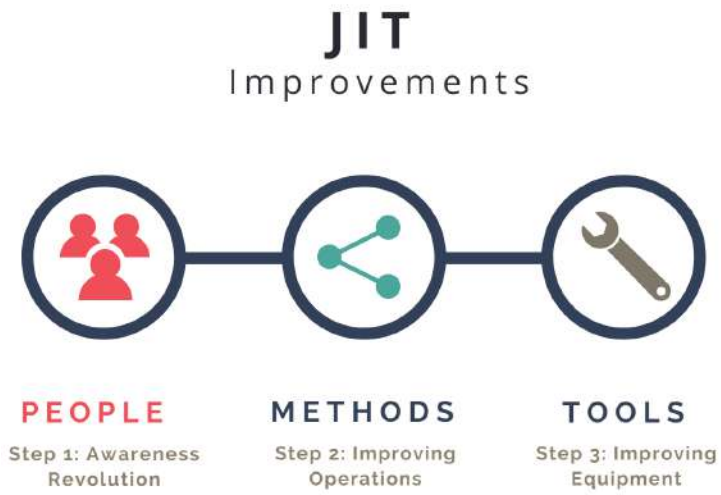

Figure 2.8. Sequence for implementing JIT strategy (Hirano, 2009)

consciousness to redesign operational characteristics and embody complementarity within different methodologies; where "*surviving*" is not enough and "*to adapt*" is critical (Hampson, 1999, Schonberger, 2007, Seddon and O'Donovan, 2010).

Indeed, under this "*learning organization*" umbrella, what is called "*on-the-job training*" reveals constantly reinforced education fostered by the JMP as a whole (Štrach and Everett, 2006, Schonberger, 2007, Leandro-Elizondo et al., 2016). Exemplifying, Toyota is a learning organization derived from the value of management and employee commitment to improving performance through Kaizen activities (Schonberger, 2007, Bhasin, 2012, Bortolotti et al., 2015). Some measures taken include supplier technology demonstrations, competitor teardown analysis, quality checklists and matrices, know-how database, program manager conferences, business revolution teams, OJT skills matrices, etc. (Bortolotti et al., 2015).

A further issue to discuss is the effectiveness of this learning-based transformation that flourishes sooner if leaders are aware of the need and engage more quickly (Štrach and Everett, 2006, Lodgaard et al., 2016). The previous chapter has shown that from the 1980s to date, many managers persist in committing the same "*management errors*" in implementing Lean, resulting in frustration and shocking results, slowing their momentum and discrediting the benefits obtained. What is more, Morieux (2011) explained that, in the last 15 years, in tangled companies, directors spend 40% of their time writing reports and 30% – 60% in meetings, leaving little space to work with their teams. As a result, employees are often diverted and spend a lot of effort in vain.

Around this, during an interview, Deming has been emphatic in asserting that "*Today's management does not know what their job is. In other words, they do not understand their responsibilities. They do not know the potential of their positions. Now, if they did, they do not have the necessary knowledge or skills. There is no substitute for knowledge*" (Stevens, 1994) . Given this situation, JPC/JICA experts have recommended that the tangible commitment of executives should be reflected through "*money, time and work*" (Suzuki, 1993, Fukuda and Sase, 1994, Morieux, 2011). True leadership consists of training employees to develop their problem-solving skills, as well as providing

money and time to implement these improvement projects (Japan Productivity Center, 1988, Leandro-Elizondo et al., 2016). Therefore, the central idea of this thinking is that everyone has a process-oriented approach, but especially those most responsible (Japan Productivity Center, 1988, Asian Productivity Organisation, 2014).

Reinforcing even more, Susuki (1993) and other experts have affirmed that "*Workplace represents a new horizon to produce profits!*" bearing on this cost reduction context and the directors obligation in it. To reinforce this aim, they also endorsed reliance on the five "*Gen*" principles for the renewal of desirable mentalities so that productivity and quality were improved (Fukuda and Sase, 1994). These "*Gen*" are:

- **Genba** (Gemba): means a "*workplace*" where value is created; it is built upon believing that productivity and quality outputs become physically tangible at the workplace. While the workers are the ones who best understand current conditions, yet they need guidance from the management and supervisors (Fukuda and Sase, 1994, Ohno, 2012). Ohno (2012) noticed that "*It is relatively easy to persuade people on the gemba with examples*".
- **Genbutsu**: to delve into the real object or condition to judge the relevance of the problems. Search for the "*Source*" of the difficulties set up as where Production capacity (including maintenance), Quality, Cost (price for customer), Delivery (production sequence), Safety, Moral, Environment and Image (PQCDSMEI). As such, seeking critical issues first look for "*PQCDSMEI*" (Suzuki, 1993, Hirano, 2009). Ohno (2012) has noted, "*Genba and Genbutsu have the information. We must listen to them*".
- **Genjitsu**: stands for the 'current state' to determine exactly where there is need for improvement actions and to identify causes and countermeasures. After detecting any critical problem (PQCDSMEI), the waste is detected in an in-depth data scaled survey. It is about evaluating each "*thing*" encompassed by an objective view over the situation in terms of 4M: Man, Material, Machines and Methods (Hirano, 2009).
- **Genri**: entails pursuing principles or beliefs from general theories and scientific style in a complementary manner when dealing with critical situations (Japan Productivity Center, 1988).
- **Gensoku**: indicates use of norms and procedures followed since standardization provides evidence for further improvement (Hampson, 1999).

Hence, as a summary, the "*Gen principles*" can be gathered, as managers must go to the Genba (workplace) to see the Genbutsu (relevance of the problems), to understand the Genjitsu (in detailed data collection) by comparing against the Genri (principles and theories) then to Gensoku (to standardize) for setting enhancement targets. As a summary, this section is an attempt to demystify how JMPs heritage strategies addressed cost reduction in coherence with delivering value and waste elimination. As Porter (1996, 2001) also pointed out, the strategy is to align objectives so that all actors can make mutually supportive decisions. Consequently, Lean should be acknowledged

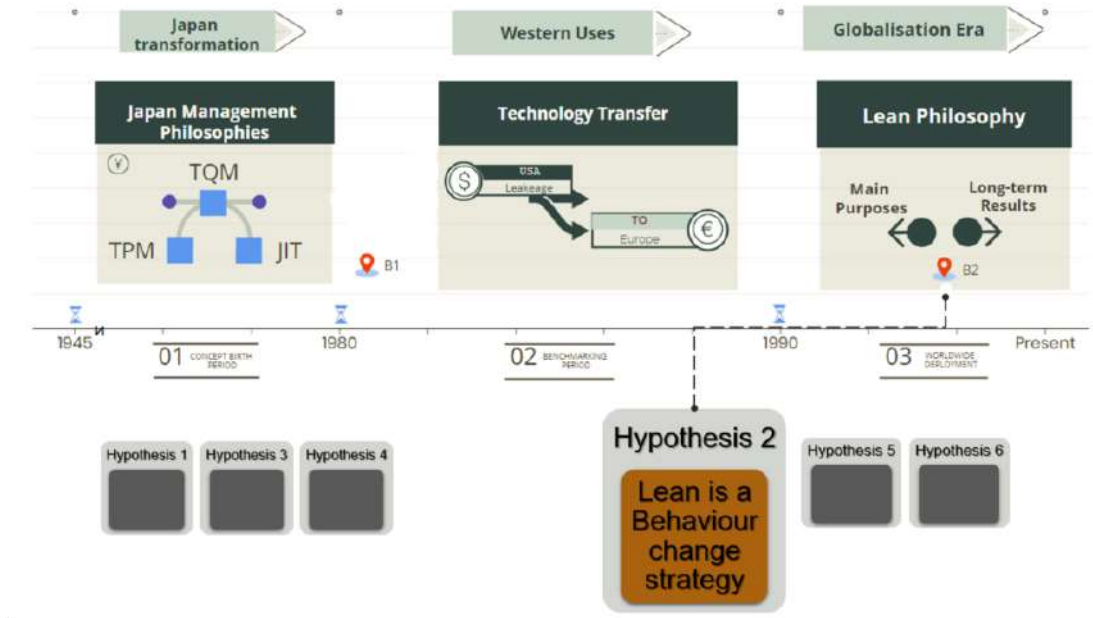

Figure 2.9. Lean as a socio-technical strategy

as a twofold competitive strategy: social and operational (Hines et al., 2004, Bhasin, 2012). Indeed, through it, a learning organization is encouraged by inducing a cognitive transformation of managers and by empowering employees under an atmosphere of mutual trust and values prior to any drastic change (Atkinson, 2010, Losonci et al., 2011).

As presented in part B2 of Figure 2.9, for the researcher, Lean is a complex system to be seen as a strategical management philosophy built on technical and human attributes, tackled to connect transformation and enhancing corporate productivity. In this way, a scenario emerges and is outlined in:

Hypothesis 2: **Lean is a business management long-term strategy centred on behavioural and socio-technical aspects**.

5. Productivity... does it support Lean initiative? Is it underestimated?

As seen in previous section, Porter (1996) has made clear that strategy along with operational efficiency are critical characteristics for boosting business throughput. With regard to LP, many authors have referred to conceptualization problems, including Pettersen (2009): "*It can be said that Lean (barely) passes the test of convergent validity, although there is no clear agreement among the authors on the general purpose of the concept*". Such findings suggest to the author that there is a missing loop caused by transferability problems with Lean deployment as a social-technical strategy and its primary purposes, to be discussed in this section.

Note that Bloom et al. (2007) have explored the connection between different types of industry practices (e.g. Lean) and performance in 4,000 SMEs in Europe, US and

Asia. They found a lot of companies that simply do not recognise that they continue to run their businesses incorrectly whilst unexpectedly few of them have struggled to shift managerial conduct. In addition, having trained people (managers and staff in general) is a significant potential source of improvement. This is why Porter et al. (2001) encourage executives to "*go back to basics*" if their aim is to remain in the market. Under these circumstances, nobody is capable of doing a good job to achieve profitable results unless they have learned the basic concepts of how to use equipment/tools/techniques properly, a "*revolution of consciousness*" must be made (Hirano, 2009, Ohno, 2012). One example of this renewal is the JIT strategy that abandons old concepts and introduces a revolutionary way of thinking (Hirano, 2009).

Meanwhile, JPC/JICA pundits have argued that reaching "*Excellence*" is about linking all JMPs and, furthermore, that they depend on productivity for the ongoing quest for greater competitiveness (Japan Productivity Center, 1988, Shah and Ward, 2003, Bhasin and Burcher, 2006). A number of authors believe that their combined use facilitates and increases the application of others and conceptualises those management philosophies as packages (Lewis, 2000, Shah et al., 2008, Furlan et al., 2011). The Furlan et al. (2011) case, in which 266 plants in nine countries were instrumented from 2005 to 2007, has used this theory to demonstrate the complementarity between TQM and JIT. It is also has tied up with human resources which capitalise directly on the organisation's overall results in terms of productivity and quality levels, cost reduction, management and employee commitment, and the involvement of suppliers.

JICA consultants have clarified when to choose the most suitable strategy for an organisation. In Figure 2.10, during the initial state of implementation, if quality is the primary focus, then the project starts with the TQM, whereas if cycle time reduction and inventory are the core, then the JIT may be the target. In the case of maintenance, TPM may be the appropriate initiative (Fukuda and Sase, 1994, Pettersen, 2009, Suárez-Barraza et al., 2011). Many authors argue that the synergies of these practices depend upon a common denominator – the productivity integrated framework – (Japan Productivity Center, 1988, Fukuda and Sase, 1994, Sunaga, 2006).

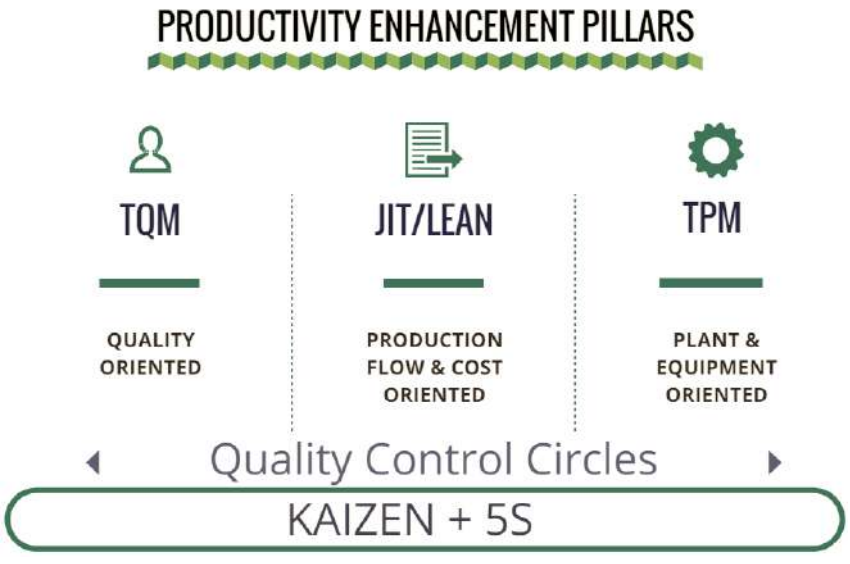

Figure 2.10. Productivity Enhancement Pillars. (Fukuda and Sase, 1994)

From the inference drawn by these authors, in the course of the benchmarking process, US professionals have narrowed the scope of their research to TPS. They have failed to explore more deeply the circumstances of Japan's complicated post-war scenario affecting their industries.

From the 1950 onwards, the Nippon Government's policies have been palpable in the light of the importance given to Productivity, which has implicitly influenced Toyota and its TPS model (Toyota, 2014) (see Figure 2.11). In the Annual Report (1998), the company has dedicated to productivity an entire chapter entitled "*Productivity: It's a matter of Life and Death*" as a building platform to growth. The same opinion was shared through the whole country (Japan Productivity Center, 1988, Asian Productivity Organisation, 2015).

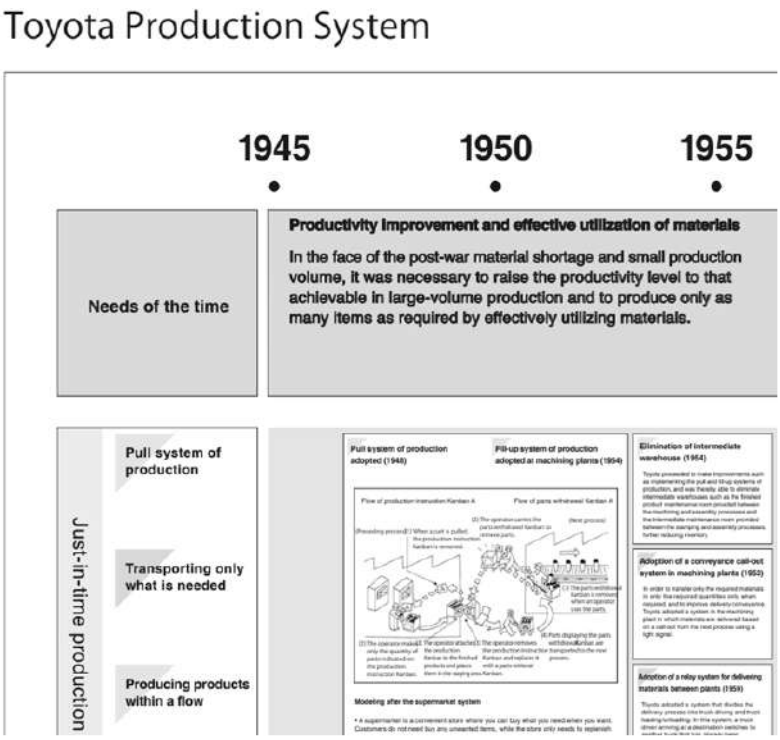

Figure 2.11. Fragment of diagram about the Productivity beginnings in Toyota's history (Toyota, 2014)

Then, what is Productivity and why is it so important to support JMP?

Apparently, it is a very well-known concept. APICS 6.11.1 defines it as "*the overall measure of the ability to produce a good or a service. It is found by comparing actual output of production to actual input of resources. Productivity is a relative measure across time or against common entities*" (Castle and Jacobs, 2011). Another definition is that it can be determined by the (production achieved - effectiveness) over the (invested effort to attain the result - efficiency) (Prokopenko, 2000, Coelli et al., 2005, Syverson, 2010). Consequently, greater productivity can be obtained via efficient and effective use of resources such as labour, capital and materials in the creation of products and services (Spring, 2011, Asian Productivity Organisation, 2015). The underlying concept is that the quality and quantity of output depend simultaneously of the input and of processing activities. In fact, quality and productivity are parallel concepts in JMP (Shimada and MacDuffie, 1986, Fukuda and Sase, 1994).

In an interview, Porter avowed that "*In order to understand the competitiveness of nations it would be necessary to adopt a bottom-up or microeconomic approach*" (Snowdon and Stonehouse, 2006). With respect to its importance, Productivity enables firms to raise competitiveness, develop environmental sustainability and make valuable social impact. All of this eventually leads to the economic wealth of a nation (Japan Productivity Center, 1988, EANPC, 2005). Paul Krugman affirms that "*Productivity is not everything, but in the long run it is almost everything*" (Office for National Statistics, Great Britain., 2007). Even though the concept is simple yet heterogeneous, it seems that each domain captures it in its own way. As a case in point, in Finance, it is established to maximize the use of money; in Economics, it sets governmental and economical macro-level policies, whereas for plant managers and engineers it requires to reduce waste through process flexibility or work study. In Human Resources and Industrial Psychologists, it deals with the respect of workers' competences (Prokopenko and North, 1996, Bloom and Van Reenen, 2011).

In any case, the above definitions and views clearly suggest a strictly result-oriented expression about how profitability can be attained by the strong influence of the prices that companies pay for their resources as well as receive for their goods or services (EANPC, 2005, Miller and Atkinson, 2014). Thus, many adherents tend to dwell exclusively on the technical-statistical accuracy of Productivity Indexes (Fukuda and Sase, 1994, EANPC, 2005).

On the contrary, productivity should be more directly aligned on the (socio-technical) performance of managerial practices, since it is tied to both human talent and organizational development to capture the true nature of TPS (Figure 2.12) (Birdi et al., 2008, Powell et al., 2013, Taylor et al., 2013). Deming[3] has acknowledged this idea "*What we need is cooperation and transformation to a new style of management. The route to transformation is what I call Profound Knowledge*".

Now, many companies have failed to deploy LP due to a lack of proper comprehension, execution and incorporation of productivity and quality gains within social systems (Shimada and MacDuffie, 1986, Suzuki, 1993, Schonberger, 2007). Certainly, an imperative prerequisite to the successful transfer of JMP, even of Lean, is "*back to basics*", which means a solid socio-technical basis given by productivity, which Western experts have bypassed for many years (Fukuda and Sase, 1994, Sunaga, 2006, Leandro-Elizondo et al., 2016). Within the above perspective, the following premise is made (see Figure 2.13):

Hypothesis 3: **Productivity Holistic Approach as underpinning Lean has been ignored by US benchmarking efforts**.

Evidently, a further discussion on Productivity is required to justify this premise. First of all, the main thrust of this integrated and systematic notion is due to the collaborative efforts of various disciplines, for example, science, engineering, economics, finance and psychology, through the combination of some of their principles (Asian Productivity Organisation, 2015). Thus, the true nature and purpose

[3] https://deming.org/explore/so-p-k

Figure 2.12. A Toyota leader's vision of TPS; a socio-technical model (Liker, 2005)

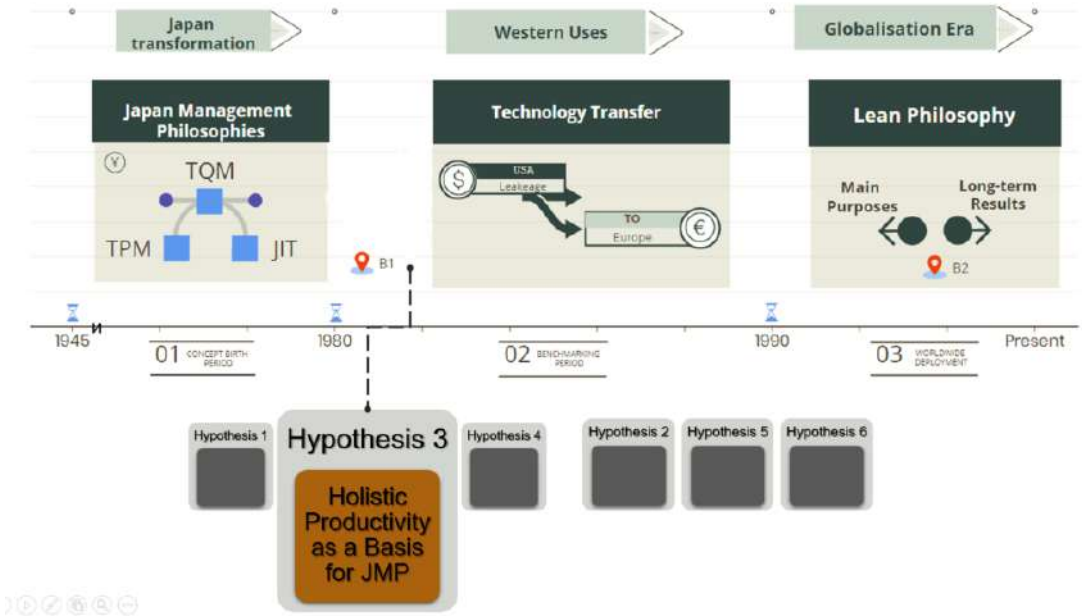

Figure 2.13. Holistic Productivity foundation for all JMP

of the Japanese style is the Productivity Movement (definition, objectives and guiding principles).

This line of attack, which is built into a growth platform, is referred to on the JPC website[4] as an extraction from the Hutton report (1953) entitled "*We Too Can*

[4]http://www.jpc-net.jp/eng

Prosper. The Promise of Productivity that still applies: Productivity is, above all, an attitude of the mind. It seeks continually improve what already exists. It is based on the belief that one can do things today better than yesterday and tomorrow better than today. Also, it requires a lot of efforts to adapt economic activities to changing conditions applying new theories and methods. It's a firmly believe in the progress of the human being."

In fact, this declaration entails an expansion beyond technical trends. The Centre conveys this as a notion of the mind undertaking a march unto perfection (Sunaga, 2006, Leandro, 2007, Asian Productivity Organisation, 2015). Continuing with this course of action, thereupon, it must consider the following objectives that matches the meaning:

- Social / Motivational: to make things tomorrow better than today and upload morale. TPS is formed by the surrounding social settlement and industrial relations system (Hampson, 1999, de Menezes et al., 2010). In such situation, the primary goal for this productivity interface is to influence behaviour over employee satisfaction. It promotes participation and a continuous improvement attitude that are trustworthy breakers of the normal "*change resistance*" (Fukuda and Sase, 1994, Leandro, 2007, Dombrowski and Mielke, 2014).
- Economically: to trigger more value to products and services and fair distribution of profits. Porter says that "*the true metric of competitiveness is the productivity of the resources utilised in that location*" (Snowdon and Stonehouse, 2006). Indeed, this aim tends to pursue a profitable corporate growth by enhancing the value added promoted by caring employees. Likewise, Deming's Figure 2.14 2.14 sets out a scenario in which quality and productivity contribute to a large number of shareholder benefits in the form of higher profits and greater employability. It envisages compensation to incentivise all actors by their contributions (Fukuda and Sase, 1994, Haghirian, 2010, Leandro-Elizondo et al., 2016).
- Technically: a higher quality of the products/services and a ratio between outputs and inputs. Mostly, it deals with measuring overall throughput capabilities and setting out the way a business progresses (Japan Productivity Center, 1988, Spring, 2011, Leandro-Elizondo et al., 2016)

One last element linked with this framework is the three guiding principles for boosting competitiveness (viewed as "*Japan on a national level, for all sectors and at firm level*") (Japan Productivity Center, 1988):

1. Growth: In the long run, improvement of productivity will increase employment. Porter has endorsed "*For a firm operating in a marketplace its gain in market share is some other firm's loss of market share. Productivity is a significant to understanding competitiveness*". (Snowdon and Stonehouse, 2006). Productivity significance rests upon it being a determinant factor impacting on economic growth and increasing welfare in the long term (Prokopenko, 2000, Office for National Statistics, Great Britain., 2007, Bloom and Van Reenen, 2011).

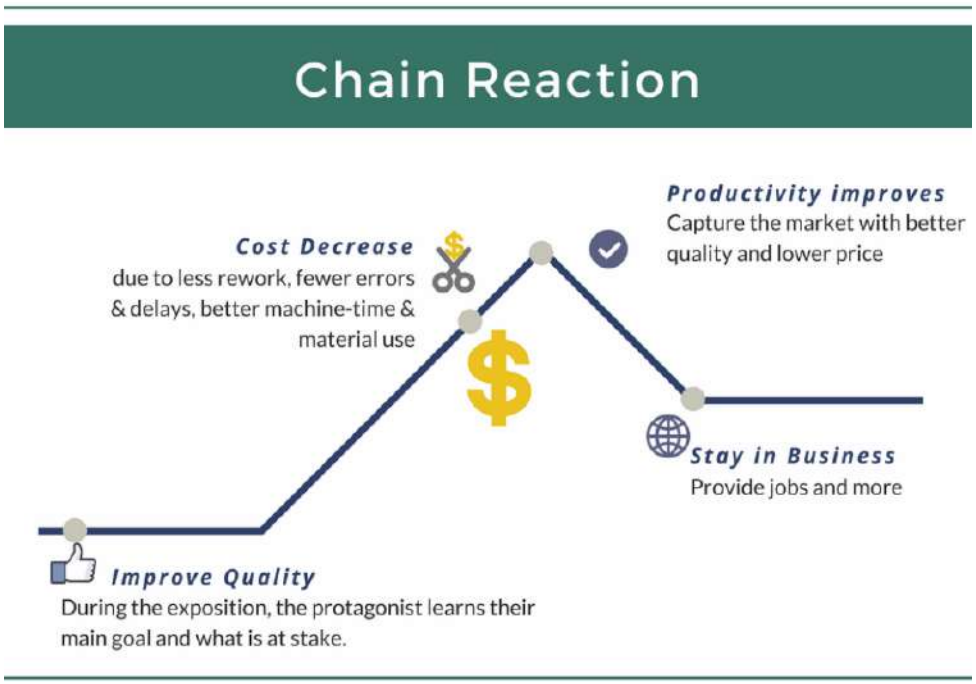

Figure 2.14. The Deming Chain Reaction (deming.org/deming-chain-reaction)

Greater demand brings more job openings; nobody would lose employment due to productivity gains (Snowdon and Stonehouse, 2006). For Japanese organizations, productivity became a lifestyle since it was what they depended on for their restoration and each company turned it into a corporate culture (Sunaga, 2006, Leandro-Elizondo et al., 2016). In Toyota's Case, TPS[5] was brought to light due to survival problems during the post-war period. Kiichiro Toyoda, Toyota's CEO, has made plans to develop novel businesses (food, clothing and housing) that preserve livelihoods for his employees. Similarly, Mitsubishi Corporation has been labelled as a carmaker, yet it has diversified its operations into the food, energy, finance, chemicals, machinery and banking sectors, tending to create more jobs (Leandro, 2007).

2. Humanity: in developing tangible efforts to enhance productivity; labour and management must collaborate towards discussing, studying and deliberating such measures. As Drucker (1999) argued, "*The most important contribution management needs to make in the 21st century is similarly to increase the productivity of knowledge work and knowledge workers... knowledge worker is both seen and treated as an asset rather than a cost*". Thus, only thanks to the cooperative endeavours of various stakeholders could the practical magnitudes of greater productivity be understood (Japan Productivity Center, 1988, Asian Productivity Organisation, 2015, Leandro-Elizondo et al., 2016). This nurtures mutual trust within the context of a learning organization; in this way, directors should provide structures whereby workers deliver high-quality goods and services (Emiliani, 2000, Seddon and O'Donovan, 2010).

   Figure 2.15 shows the way Deming has endorsed a new management method where learning and cooperation is a major point to consider. Under this scheme,

[5] www.toyota-global.com/.../item1.html

the kick-off is to have a visionary leadership, meaning that the chiefs must start change. Most of the time, this is not so, as Morieux (2011) has observed: "*Managers need to add value. When managers do not add value, they subtract value. So if managers subtract value is better to subtracts managers*".

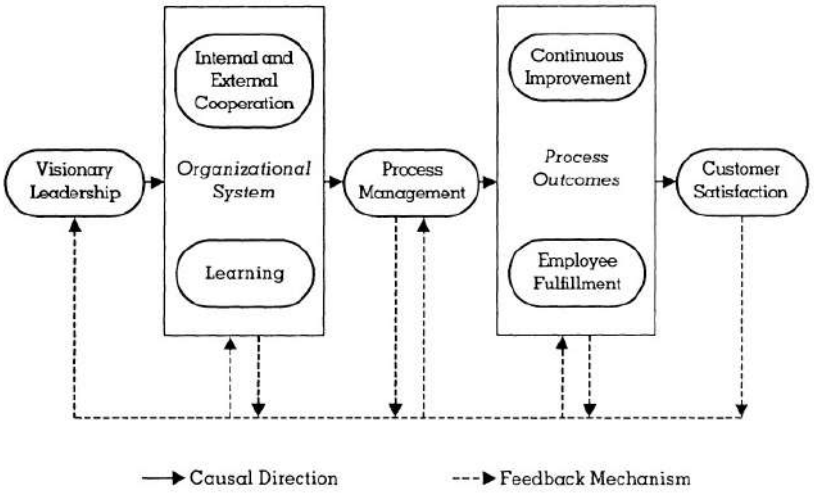

Figure 2.15. The Deming Managerial Model (Anderson et al., 1994)

Undeniably, it is a principle for joint commitment (chiefs/employees) that expand the scope; two main functions emerge for directors (Suzuki, 1993, Leandro, 2007):

- Facilitator: to encourage knowledge workers to manage themselves. It is necessary to provide the proper know-how (OJT system) and autonomy to encourage workers to solve simple problems (Fukuda and Sase, 1994, Drucker, 1999, Leandro, 2007). Besides, it also covers practical leadership from employers seeking to gain independence, including follow-up of workers' self-reliance projects at the gemba (Birdi et al., 2008, Losonci et al., 2011, Dombrowski and Mielke, 2014).
- Researcher-Developer: Deming has proven that "*85% of faults are attributable to variability of the system, processes, structures and practices, 15% are related to people and it is the responsibility of management to fix this*"[6]. While employees continue to tackle simple challenges, managers are likely able to concentrate attention onto more sensitive issues or developing straightforward strategies (Porter, 1996, Hines et al., 2004, Leandro, 2007).

3. Fairness: The fruits of productivity must, in correspondence with the condition of the national economy, be distributed fairly among management, shareholders, labour and consumers. What is the purpose of a business? Peter Drucker has answered to this question as "*to create a customer*". He then explained that a business is "*an organisation that adds value and creates wealth*" (Watson, 2002). Behind this position, there is a concern on how to maximize stakeholder value, suggesting an equitable burden of profit on those who have translated attitude into action (Fukuda and Sase, 1994, Emiliani and Stec, 2005, Morieux, 2011). Hence, stakeholders include personnel, directors, investors, suppliers, clients, unions, Government, society and so forth (Emiliani, 2000).

[6] blog.deming.org/2012/10/knowledge-of-variation/

Beneath such a broader perspective, productivity should be considered as a systematic pattern contributing both to value creation and to constant enhancement of the use of resources enabling growth, partnership and employment, rather than a concept dealing solely with quantifiable aspects (EANPC, 2005). For Japanese firms, productivity embodies a way of life, so they convert it into an action plan, which is included in their business culture (Stainer, 1995).

6. Why does Kaizen drift into strengthening the Productivity approach?

Taking Toyota as an example, the company resolved to share its corporate beliefs with the intention of expand its knowledge properly. Two main pillars support it: Respect for people and Continuous improvement (Toyota, 2014). About the first part, undeniably, this statement could be subtly matched with Hutton's words: "...an attitude of mind... and believe in the progress of human being", which without any doubt refers to Productivity, as explained before.

Similarly, a comparison can be made concerning Toyota's 4P model where principles and continuous improvement play a crucial factor inside TPS (see Figure 2.16 , including the one of Figure 2.10 through which JPC experts apprehended the importance of productivity integrated framework as the start-up for growth based behaviour change. If Productivity is a persistent pursuit of perfection, in this sense, Kaizen has a close liaison with it (Ohno et al., 2009, Suárez-Barraza et al., 2011, Ohno, 2012).

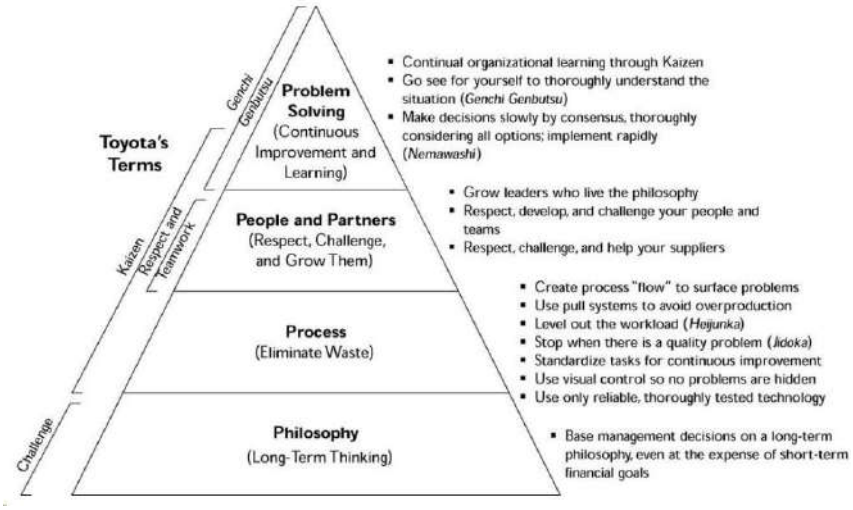

Figure 2.16. Toyota's 4P model (Liker, 2005)

Despite the tacit similarities between the two concepts, the transfer drawbacks reported in section 2 of this chapter persists. It also applies to Kaizen, which in Japanese is not exactly interpreted as "*continuous improvement*", its literal sense being "*change for the better*" (Suárez-Barraza et al., 2011, Leandro-Elizondo et al., 2016).

6.1. KAIZEN or Kaizen: Is there any difference?

Suarez-Barraza et al. (2011) consider that "*Kaizen goes further than the Western notion of Continuous Improvement... There is still a dearth of acquaintance in many big companies and it increases in SMEs' cases that needs to be treated*". Traditionally, business theorists' perceptions have used the term loosely by simply alluding to tools (Schonberger, 2007, Murata and Katayama, 2010, Suárez-Barraza et al., 2011). Even if various proponents uncover many nuances, North American influence is pervasive, dropping into fast trends such as Kaizen-Teian, Lean-Kaizen, Gemba-Kaizen, Kaizen Office or Kaizen Blitz (Åhlström, 1998, Suárez-Barraza et al., 2011, Rüttimann and Stöckli, 2016). Dombrowski and Mielke (2014) have recognised in their study that 90% of the interviewed companies had implemented continuous enhancement events and set its importance. Yet, Lean experts pointed out that less of 10% of the firms actually apply it since they did not really comprehend its real scope. Katsumata, Deputy Director General of JICA, defined Kaizen as a "*Japanese management philosophy and know-how that brings about continuous improvement of productivity and quality. It intends all individual's behaviour changes, promoting their creativity and ingenuity*" (Ohno et al., 2009, JICA, 2011). As the author strongly urges, a major challenge when adopting LP has been the noteworthy and fragile mode being used to transfer the original concepts with a direct bearing upon its good functioning. In this respect, Susuki (1993) considers that "*The same tools can produce extremely different results*", that is, without acceptable understanding of the different theories, the result will not be as projected. The next overview is centred on the experts'[7] know-how around Kaizen and its relevance to the integrated productivity stream. In Japan, people use the idea to manage adverse events in their day-to-day activities, followed by the synergistic and complementary contribution of employees who use tools that turn attitudes into action (Birdi et al., 2008, de Menezes et al., 2010, Furlan et al., 2011). First, it is worth noting that Kaizen pursues four main objectives: fostering behaviour change, strengthening workers' skills, finding the root cause of problems and solving them. (Schonberger, 2007, JICA, 2011, Leandro-Elizondo et al., 2016). This is also shown by the JICA Diagram presented in Figure 2.17, providing details of the methodology, which enables the breakdown of initial resistance, given that habit is part of human nature. Simultaneously, offering flexibility, a stronger top-down relationship and a low capital investment impact on the company's performance.

As another aspect to mention, Atkinson (2010) pointed out that "*Toyota has applied several strategies for continuous improvement including Lean; at the implementation procedure should be designed, mapped and measured against the achievement of strategic and business plan*". Instead, reviewing the literature uncovered a pervasive consensus amongst Western scholars regarding the numerous tools employed without any connectivity when implementing JMP (Schonberger, 2007). Several examples of this illusory portrayal are presented in Table 2.2, which may threaten enforcement at its base. More broadly perceived by JICA experts, the model has a dual dimension to be exploited: KAIZEN - a culture-centred start-up strategy for restructuring the entire system and - Kaizen - problem-solving toolset geared to operational efficiency

[7] Japan experts from JICA and JPC: Hajime Susuki, Kenji Takemura, Yasusi Fukuda, Tohru Sase, Masayoshi Shimizu, Kasuo Tsuchiya and Yasuo Tsutsumi.

Figure 2.17. Characterizes of Kaizen and effects (JICA, 2011)

(Suzuki, 1993, Suárez-Barraza et al., 2011, Takemura, 2002). This is how the terms will be distinguished upon this document.

Authors	Year	Assertion
Emiliani	2000	The primary support tools include: 5S, visual factory, total productive maintenance, set-up reduction, mistake-proofing, standard work, one-piece flow, and Kanban
Pavnaskar et al.	2003	They have proposed an arrangement to serve as a link between waste problems and LP.
Bhuiyan and Baghel	2005	To the author's knowledge, little focus has been directed towards developing a framework or model that would enable an organisation to identify the Continuous Improvement methodology that best suits its needs
Suarez-Barraza et al.	2011	In their study, they propose the following techniques without any sequence: Quality Control Story, Process redesigns (blitzes), Value Stream Mapping, 5S and standardization, Action's plan and coaching, Process mapping and flowcharts, Quality Control seven tools, Statistical techniques, Flow balance
Bhasin	2012	He has affirmed,"Every company should discover its own way to implement Lean. There is no universal method that applies to all organisations"
Pearce and Pons	2013	They have expressed that "Unfortunately, there are no specific tools for the selection and prioritisation of methods during implementation"
Mourtzis et al.	2016	They have affirmed over several interviews to engineers and shop floor experts that "There is no structured way or employed methodology for Lean implementation nor any specific department responsible for it"

Table 2.2. Literature Review over misinterpretations of JMP

KAIZEN has led to set up a sequential baseline platform for enhancing productivity, thereby altering the overall structure as well as an organizational cultural system (Fukuda and Sase, 1994, Gapp et al., 2008, Suárez-Barraza et al., 2011). Ahlstrom (1998) has upheld this by saying that "*There are a systemic relationship between elements of the management practices so each one of those elements cannot be implemented separately*". Suzuki (1993) has settled this in detail, as shown in Figure 2.18, beginning by a systematic sequence of the Plan – Do – Check – Act (PDCA) cycle to address any project properly.

This philosophy purpose does not stagnate and needs to be permanently upgraded (Ohno et al., 2009, JICA, 2011).

The next step is Kaizen and the 5S program that embraces an inherent source of "*awareness*" breaking down early resistance by both emphasizing on how forging proper working habits combined with a collaborative climate on all levels (Fukuda and Sase, 1994, Leandro, 2007, Ohno et al., 2009).

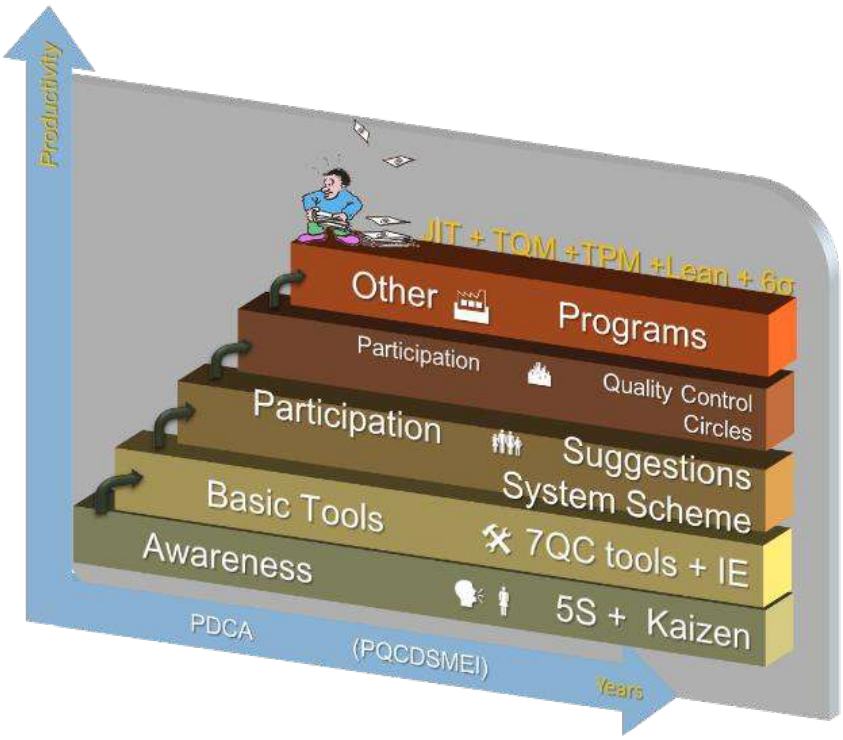

Figure 2.18. KAIZEN basic strategy model (Suzuki, 1993)

The third place is training people in the mode of OJT initially via Quality Control and Industrial Engineering (work-study) tools. Such teaching enables the exposure of challenging situations onto recognizing everyone's efforts over the vital few, encouraging a better quality atmosphere (Schonberger, 2007, Ohno et al., 2009).

Lastly, "*participation*", that is, involving and organising people in a comprehensive way for improvement through quality control circles (teamwork) and suggestion systems activities. Most of all, those practices offer the conditions which connect people to the firm's goals and decision-making are reinforced by Gen's tenets. Thus, KAIZEN systematizes the required socio-technical starting frame prior to keeping other priorities (Suzuki, 1993, Fukuda and Sase, 1994, Leandro-Elizondo et al., 2016).

Thereafter, the Kaizen dimension has been oriented onto the critical areas (PQCDSMEI) with the intention to aid in working collaboratively to reach shared targets (Suzuki, 1993, Leandro, 2007). Many Japanese pundits insist, at the same time, that a reward mechanism should be added, not just for supporting such efforts, but also for encouraging enthusiasm in everyone and maintaining constant participation (Suzuki, 1993, Fukuda and Sase, 1994, Ohno et al., 2009). Hence, senior executives need to design pro-active measures that support such a problem-solving model by developing people's skills (Birdi et al., 2008, Dombrowski and Mielke, 2014). To confirm this claim, Takemura (2002) has designated three types of kaizen:

- By ideas: by acknowledging an abnormal situation, it encourages everyone to make small improvements without much technical understanding. Some simple tools are proposed: ECRS Principles (to Eliminate, To Combine, To Rearrange, To Simplify); 5 Why's (Ask why at least 5 times); Poka Yoke (mistake proofing) and 5W1H (answer What, Where, When, Who, Why, How).
- By Analysis: it consists to solve problems systematically by using a scientific method. This includes variability analysis when converting inputs into outputs using data and cost-cutting countermeasures. This can be done with the help of quality control as well as industrial engineering techniques such as work study techniques. Systematic problem solving under this kaizen is illustrated in Figure 2.19, detailing the step-by-step procedure associated to the tools required. Initially, the current situation of the process needs to be known, searching and analysing for abnormal conditions, then providing solutions and checking results; lastly, the improvements are standardized and controlled (Takemura, 2002, Takemura and Vajna-Istvanne, 2016, Leandro-Elizondo et al., 2016).
- By Introduction of New Technology: It comprises either kaizen or innovation, bringing a higher technical productivity target (Tsuchiya, 1998, Leandro, 2007). Innovation contributes to development but it takes a lot of time and money, whereas continuous improvement relies on wisdom to better capitalize assets engaged, as depicted in Figure 2.20.

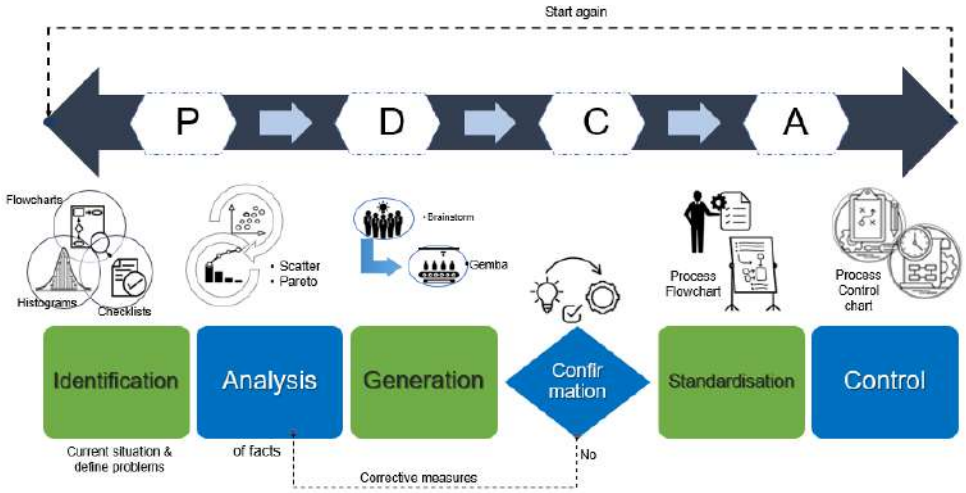

Figure 2.19. Methodology behind kaizen analysis (Takemura, 2002)

Divergences among small but continuous improvements (Japan) and drastic changes (West) dramatically disrupt Kaizen's original intention (vision, priorities and sequences) underlying its creation and leading into unexpected outcomes. Lillrank's process model (1995), would classify KAIZEN at the "*high abstraction – demand driven*" level, since actors may perceive a universal principle with several practical implications. Meanwhile, Kaizen might be in "*low abstraction – demand driven*" since the users cherish its value and strive for its quick delivery.

In fact, KAIZEN can be taken as a management means, establishing a system and making it particularly suitable for SMEs launching their journey to Lean (Ohno et al.,

2009). Kaizen by idea and by analysis are complementary methods revealing subtle ways in which management and workers are able to align their mentalities in an attempt for productivity growth (Ohno et al., 2009).

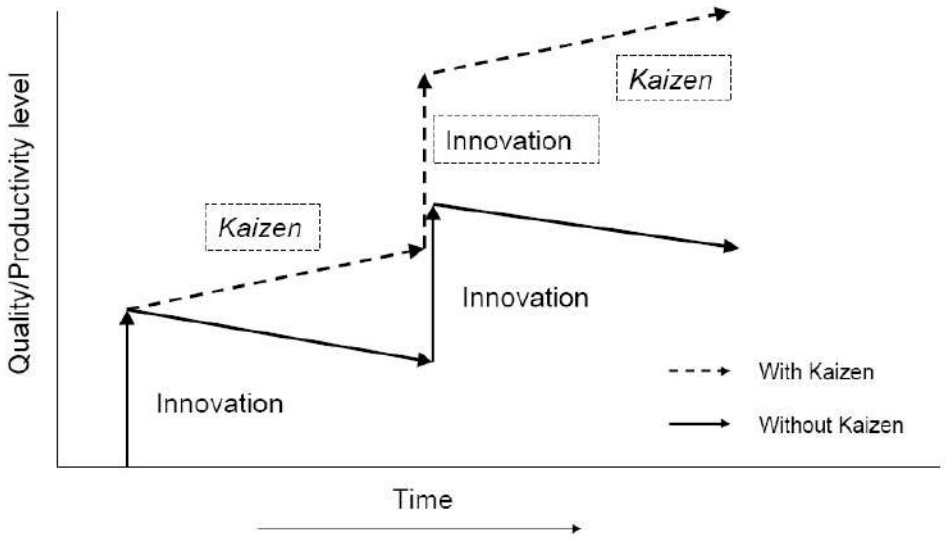

Figure 2.20. Kaizen by introduction of New Technology (Ohno et al., 2009)

6.2. 5S Program or "Housekeeping": What makes the difference?

Countless amounts of information about 5S activities can be found on the web and from consulting firms. Besides, this technique is accepted as part of any strategy (JMP) and yet most applications are very commercial and do not provide an accurate meaning picture. One such example is APICS, section 3.11.5 that defines 5S by this: "*Sort, set in order, shine, standardise and sustain are five terms beginning with the letter S used in creating a workplace suitable for Lean production*" (Castle and Jacobs, 2011). Some theorist belief that the environment determines the behaviour (Sherehiy et al., 2007); perhaps, it is because of this that errors and ambiguity arise concerning such a technique. Typically, a first definition of 5S is simply "*housekeeping*"; curtailing its real sense and aiming to supply an efficient cleaning procedure (Gapp et al., 2008, Kobayashi et al., 2008, Leandro-Elizondo et al., 2016). Many Occidental practitioners have dealt inconsistently and lightly the programme, losing its intrinsic governing conception (Suzuki, 1993, Schonberger, 2007).

Contrary to the belief that most Japanese technology relies heavily on innovative equipment, higher levels of productivity and quality could not be achieved without 5S values (Fukuda and Sase, 1994, Ohno et al., 2009). As seen in Figure 2.21, the flow of those values enables more efficient space utilisation, reinforces safety and morale, prolongs the operating life of the assets, etc. (Ohno et al., 2009, Takemura and Vajna-Istvanne, 2016). In addition, Japanese manufacturers consider the implementation of 5S as the minimum requirement to be their suppliers (JICA, 2011).

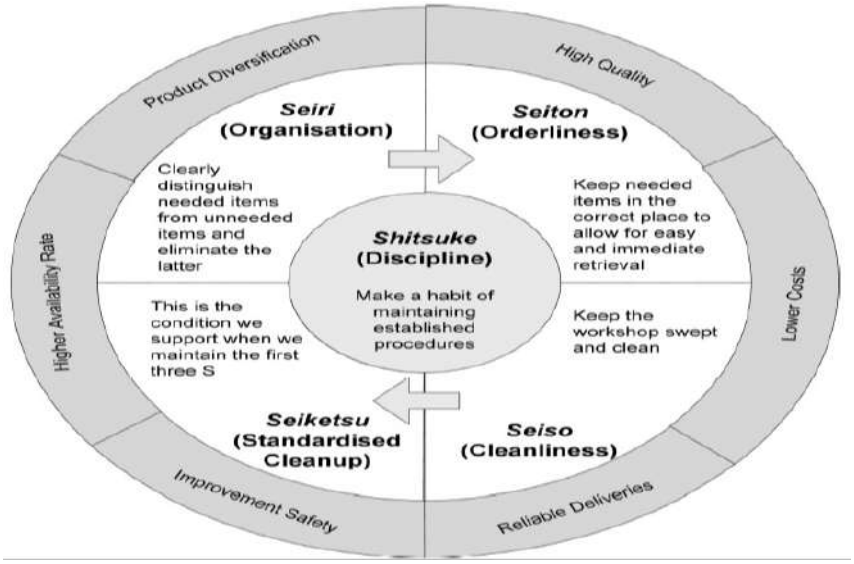

Figure 2.21. 5S outline supporting critical issue oriented approach (Hirano, 2009)

There is a Japanese expression "*Fools and scissors are useful if handle properly*" (Ohno, 2012). In the same direction, Susuki (1993) has proposed a coherent explanation of this assertion and has detailed it into the right understanding, practical application, practical techniques and integrated activities.

The right understanding: Tsuchiya (1998) defined 5S as "*A participation program for small group activities that look forward to improve the productivity and work environment*". To fulfil its potential, he outlined its main objectives: to build good teamwork through participation, to encourage managers and supervisors for a practical leadership, to develop KAIZEN minded people and to optimise facilities conditions for introduction of advanced KAIZEN technologies. The participation is meant to empower workers as they know whence the sources of the troubles lies and usually have a better idea of solutions than managers; likewise, enthusiasm rises to meet goals and, finally it stresses minor investments by cutting waste (Ohno et al., 2009,JICA, 2011). The general competitiveness function of Susuki (1993) is represented in Figure 2.22 as F (Value Added, Productivity).

Figure 2.22. Basic overview towards Competitiveness (Suzuki, 1993)

Alluding to this transforming aspect given by the 5S, an organisation can simultaneously boost quality and lower costs, while at the same time ensuring a quality of life for all stakeholders (Fukuda and Sase, 1994, Emiliani, 2000, Takemura and Vajna-Istvanne, 2016). Attitudinal change can be achieved across stages of awareness, understanding, conviction and action (Schonberger, 2007, Atkinson, 2010). A high-quality product/service could only be generated in a well-organized workshop setting when people plan, do, check and act (Tsuchiya, 1998, Takemura and Vajna-Istvanne, 2016). In the meantime, the lowering of wastage and costs stems from the pooling up of working elements (4M), instruments and functions needed within people in their daily routines and can be graphically explained as shown in Figure 2.23 (Takemura, 2002, Ohno, 2012).

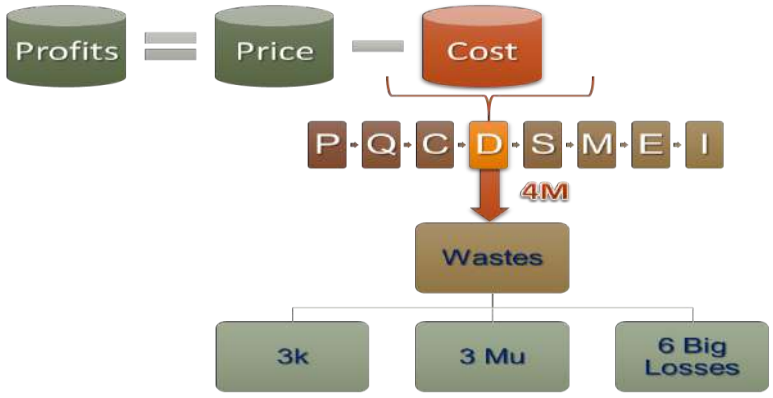

Figure 2.23. Outline of the overall Productivity-based Waste and Cost Reduction focus

The practical application: the initiative stands for five Japanese concepts that starts with S, easy to understand by everyone even to workers lacking of adequate educational proficiency. They are valid everywhere because they are universal principles and have well ordered, step-by-step, clearly defined phases, as shown in Table 2.3, where the actual designation, the purpose behind them and how they are distributed can be found (Suzuki, 1993, Fukuda and Sase, 1994, Tsuchiya, 1998).

From the author's expertise, the practice unfolds two specific dimensions: external and internal. Firstly, the external dimension is addressed by applying the first 3S. It tackles the working activities as well as the interaction with the factory's atmosphere. Likewise, they are simple elements learned at home; this would be merely the "*cleanliness*" side for achieving greater competitive conditions.

Then, the last 2S have to do with the attitude or the inner part, each person's "*consciousness*". An enthusiastic employee can make a significant and adjusted impact to promote the critical issue in a proactive manner within the organization (Emiliani and Stec, 2005, Birdi et al., 2008). On this point, Drucker (1999) affirmed that "*Knowledge workers have to have autonomy that entails responsibility. Continuous learning and continuous teaching have to be built into the job*".

Practical techniques: according to Tsuchiya's proposal (1998), the 5S Master plan efforts have several stages (using PDCA) but contrary on what is expected, it starts with the last one Shitsuke: preparation, CEO's kick-off official announcement, Initial Big Seiri activity, daily Seiri - Seiton - Seiso and Big Seiso and periodic Audits events.

Concept	Definition	Purpose behind the concept	Practices
Seiri	To eliminate items & quantity which are unnecessary	Clear Criterion & Instruction	- To classify between necessary and unnecessary. - To define the Waste Area or "graveyard" and classify it, (Recycling, Recovery, Waste). - Red Tag method. - To make a list of all items to be disposed
Seiton	A place for every item & every item in its place	- To order necessary items, ready to use - To prevent time & transport losses - In fail save: no chance of misused and prevent accidents	To apply three main principles: - The 30 seconds rule: to find any ítem in less than 30 sec - FIFO rule: first in first out - Everything in it's place Principle: by signaling and labeling
Seiso	Cleaning with inspection	- To collect dust without scattering - To remove dust without damaging To check & correct abnormal conditions	- To know the equipment. - To verify functionality (through senses: see, hear, product, feel and smell) - To understand basic levels of machines
Seiketsu	To keep a high standards of the first 3S	- To reveal current situation by: detecting fails causes & problems, standardising or temporary reference measuring, taking actions for abnormal situations, accumulating knowhow, formalising experimental standard, communicating standards, improving standards with experience	- To apply procedures and visual controls
Shitsuke	Discipline through constant training	- To foster morality and ethics come first through rules - To foster prevent and predict environment - To measure behavior change	Continuous Training. - Applying the Gen Principles regulations & work standards. - To push up others - To apply with KAIZEN

Table 2.3. 5S Program's Meanings and Purposes (Suzuki, 1993)

This is a "*bottom-up*" program; thereupon, it is recommended to create a steering committee, in which managers will not be included. Grounded on author's experience, the implementation procedure can be completed in a period of time between 6 to 9 months, depending on the importance that the company gives to the methodology. Then, the sustainability phase initiates with some specific actions: constant training, congresses, company visits, internal competitions, promotion and contests, rewards, Big Seiso and Seiri activities, intercompany 5S competitions: updates & benchmarks.

Integrated activities: Once implemented how to continue with it? According to the Japanese experts, a combination of KAIZEN and 5S is recommended, where the efforts should be directed towards following up and emphasising the "*Critical-Issue orientation*". Gradually, it should be expanded through autonomous activities with co-workers, the application of the Gen Principles by supervisors and managers, and follow-up by staff departments such as engineering or marketing. Afterwards, the project team should deepen the Kaizen practice through analysis by engineers or creating a Kaizen database (Takemura, 2002). Shimada and MacDuffie (1986) have summarized this entire Japanese strategy (see Figure 2.24), known as "*Human-ware*". On one hand, it contains corporate objectives; while on the other hand, it includes the necessary attributes to enable employees contributing to productivity. In the middle, Kaizen and 5S critical features should be mentioned, for supporting all personnel in their cost-cutting efforts. A team spirit, mutual trust and participation can be underlined as decisive elements in enhancing workforce proficiency because of skills, adaptation and motivation. Fukuda and Sase (1994) have seconded the Human-ware model and expressed it mathematically as **Output = Skill * Attitude**.

They claimed that positive thinking can be settled through the cultivation of a continuous improvement habit, at everyday operations thanks to well-planned KAIZEN. In tandem with that, Katsuaki Watanabe, Toyota's CEO, said that "*The root of the Toyota Way is to be dissatisfied with the status quo; you have to ask constantly, why are we doing this?*" (Ohno et al., 2009).

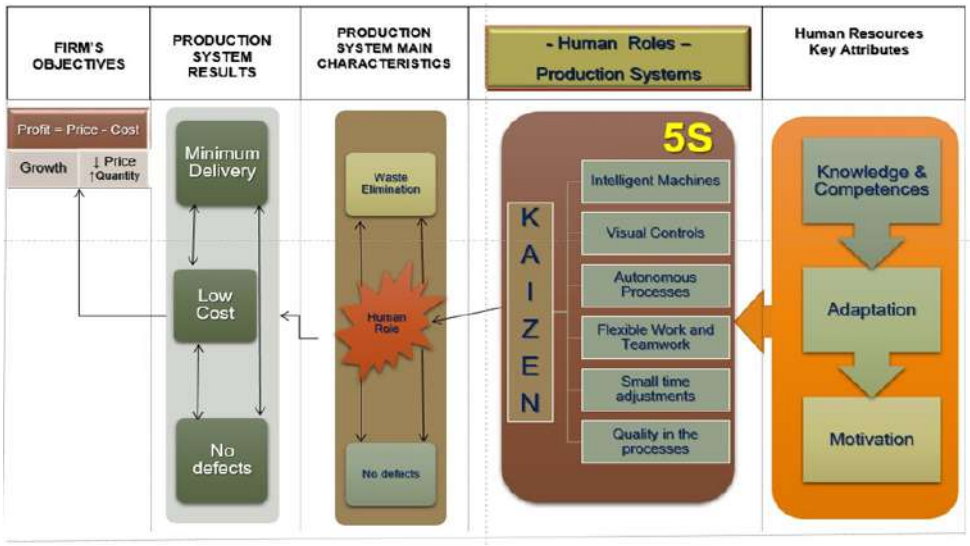

Figure 2.24. Humanware approach-Japanese Strategy - (Shimada and MacDuffie, 1986)

From the foregoing, a question arises: by adopting Housekeeping instead of a 5S program, would the same result be obtained, and why? If both perceptions were compared, and following Lillrank's Transfer Channel model (1995), it is possible to justify that housekeeping remains under a low abstraction-demand driven. This indicates that its source attributes are not captured and that its strength would be undermined. In this case, users would not recognize its full potential and would seek fast application. Not surprisingly, western enterprises, when auditing 5S, assess its endeavours to measure effective cleanliness elements.

On the opposite, KAIZEN basic strategy properly implemented will influence directly all Lean philosophy (Takemura and Vajna-Istvanne, 2016). In fact, the author's opinion is that the executives must strive to measure 5S in ambitious terms to maximise the outcome. At this point, the primary audit concern should be measuring behaviour change. Yet, this is often ignored or denied by the body of knowledge. In order to accomplish the expected Lean breakthrough, the whole organisation is severely constrained by its implementation procedure (Emiliani and Stec, 2005). On this matter, Porter et al. (2001) have pointed out that "*the old rules regain their currency*". Bearing this in mind, the following hypothesis is made and drawn up in Figure 2.25:

Hypothesis 4: **KAIZEN is imperative to prompt productivity enhancement and it provides an initial platform to discipline working culture**

7. Measuring Lean: Contribution to Business Intelligence

Just as previously noted, a strong requirement has been placed upon businesses to be both competitive and profitable (Watson, 2002, Snowdon and Stonehouse, 2006). Concerning this matter, APICS in point 2.4.2.1 has recognized that "*Profit is*

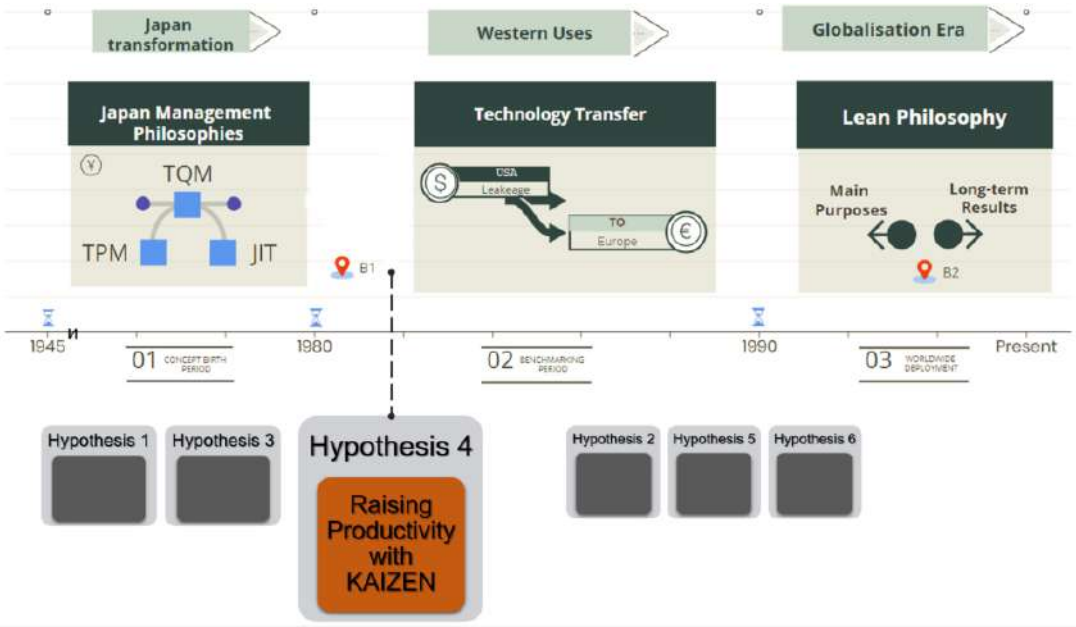

Figure 2.25. Integrated Productivity Improvement basic Strategy

the most significant measure of business success" (Castle and Jacobs, 2011). On the other hand, within supply chains, it is well known how large and small companies interact. Commonly, corporations place high pressure upon SMEs both in production and in their management systems for better functioning (Grabot and Mayere, 2009). Insofar as many SMEs function within sectors where there are few impediments to new entrants and where they have limited bargaining position in dictating their needs to suppliers, they are vulnerable (Achanga et al., 2006). Indeed, in France, for instance, the financial performance of small and medium-sized enterprises has been steadily deteriorating since the 2000s (Moeuf et al., 2016).

For this type of firm, there is evidence that its operations tend to be very reactive to ever-changing circumstances (Achanga et al., 2006, Moeuf et al., 2016). Its style of management is correlated with various outcomes, such as delivery time, number of employees and return on investment (Achanga et al., 2006). This is why senior executives persistently strive to standardize and improve the effectiveness of performance evaluation and assessment methods (Gregory, 2007, Bhasin, 2008). Now, owing to both competitiveness and strengthened governance, Lean is a viable opportunity to address these threats (Grabot and Mayere, 2009, Moeuf et al., 2016). Its introduction will affect the entire value chain directly (manufacturing, sales, customer service, human resources, finance, etc.) (Lewis, 2000). Insufficient understanding of how improvements made in one area will affect another, or lack of them, may lead into failure to obtain the desired transformation (Lewis, 2000, Bhasin, 2012, Almeida Marodin and Saurin, 2015).

Under these scenarios, in any given strategy, metrics are required to enable proper decision-making and, simultaneously, to serve as a means of communication within the company (Kaplan and Norton, 2001a, Arteta and Giachetti, 2004). There is no performance without measuring when its significance lies behind tracking outcomes (Poveda-Bautista et al., 2012, Galichet, 2018). This includes the strict setting of top-down

objectives, the collection of feedback information on the functioning of the system, and the use of reward and penalty policies to bring the results closer to the goal (Gregory, 2007). Considering this introductory overview, this section will attempt to show the importance of measuring the performance of any strategy over an organization. As discussed in Chapter 1, this has been another Lean obstacle faced over time. For the author, such LP performance appraisals have been addressed individually by each area of the value chain; the emphasis should be more on system-wide measurement. Added to this, every department speaks its own measurement language that differs from the one employed by top management.

7.1. Rediscovering the impact of productivity into business plan

Being competitive means business survival; traditionally, quantifying competitiveness has been either done in financial or in marketing terms (Porter, 1996, Kaplan and Norton, 2001b, Cao et al., 2015). The APICS, in its section 2.4.2.2.2, mentions that "*Financial accounting is the scorekeeping process of determining the success or failure rate of a business*" (Castle and Jacobs, 2011). The key point about competitiveness is that all the value chain influences it, if it offers greater value in products and services than competitors (Watson, 2002, Cao et al., 2015). For this reason, there is a direct liaison within all functional units corresponding to their operating level (capacity to act, to achieve production) (Galichet, 2018). Hence, if the performance function reflects the achievement of the goals, then the organizational effectiveness entails the performance assessment, and results tracking is correlated (Tangen, 2004, Galichet, 2018).

Notwithstanding this fact, managerial staff uses accounting criteria like net income, earnings per share, price/earnings ratio or inventory turnover, among others (Tangen, 2004, Almeida Marodin and Saurin, 2015). Most often, nonetheless, these financial metrics disseminate messages to employees that are not necessarily understood, as the workers' responsibilities overlap, as shown in Table 2.4 (Emiliani, 2000).

For instance, in manufacturing, there would be man-hours, overtime, lead times, etc. In the case of engineers, it is the mean time between failures, overall equipment efficiency, or heat transfer rate; to purchasers, this includes price, delivery time, or terms and conditions; for quality, nonconformities, defects per million, or corrective actions that matter; and to accountants, such as budget, overhead and sales costs, etc. (Emiliani, 2000).

Given this, a distinction is made between two dimensions of performance: an economic (efficiency) and a systemic aspect (organizational sustainability) , as well as a qualitative one, which is both social (human resources) and societal (organizational legitimacy) (Kaplan and Norton, 2001a, Galichet, 2018). Considering these dimensions facilitate a harmonized structure encompassing financial and non-financial components (Poveda-Bautista et al., 2012, Galichet, 2018). Nonetheless, although, many businesses may be aware of this, they are unable to truly grasp the essence of performance (Holweg and Helo, 2014, Cao et al., 2015).

CEO Mandate	First Level translation	Second Level translation
1. Double net income Definition: Net income = revenues - expenses	Increase sales/market share. Decrease expenses	Reduce: lead-time, direct and indirect costs
2. Increase cash flow by 100% Definition: Cash flow = cash receipts - cash disbursements	Increase net income Improve asset utilization Decrease cash disbursements	Increase revenues Utilize existing human, financial, physical, and material resources
3. Increase working capital turnover 30% per year Definitions: Working capital turnover = sales/average working capital Average working capital = current assets - current liability	Increase sales Decrease average working capital	Reduce lead-time Reduce accounts payable
4. Double inventory turns Definition: Inventory turnover = cost of goods sold / average inventory	Reduce cost of goods sold Reduce inventory	Reduce direct costs Reduce inventory Reduce amount of work in-process Reduce lead-time
5. Introduce ten new products over two years	Increase sales	Reduce lead-time
6. Develop new products in half the time with half the money	Revolutionary change in design practices Improve asset utilization	Apply best practices in design Utilize existing human, financial, physical and material resources
7. Reduce cost by 30%. Definitions: Direct cost = expenses that can be associated with specific products. Indirect cost = expenses that cannot be associated with specific products	Reduce cost of goods sold Improve asset utilization	Reduce direct & indirect costs Utilize existing human, financial, physical, and material resources
8. Improve product quality by 50%	Reduce non-conformances, scrap, re-work and warranty costs	Eliminate variation.

Table 2.4. Translating CEO mandates (Emiliani, 2000)

This suggests that a robust and well-balanced evaluation process should embody the organizational purposes attached to the above dimensions (Chew, 1988, Gunasekaran and Kobu, 2007). Under these premises, for the author, the criterion that meets these conditions requires an architecture based on the Japanese Productivity perception. This is connected, per se, within KAIZEN's baseline strategy (see preceding hypotheses), due to the fact that it embraces scientific and humanistic management (Sunaga, 2006, Gunasekaran and Kobu, 2007, Poveda-Bautista et al., 2012). Yet, most often, western literature has limited it strictly to technical coverage and concentrates on the statistical reliability of the indexes (outputs/inputs) (Chew, 1988, Stainer, 1995).

As well, the concept is confused, being synonymous to efficiency in many works (Coelli et al., 2005, Mankins, 2017). Efficiency is about doing the same with less in an effort to improve profitability (Tangen, 2004, Asian Productivity Organisation, 2015); while productivity (technical) consists of doing more with the same (Tangen, 2004, Mankins, 2017). At first glance, the two are remarkably similar but efficiency works to reduce the denominator - inputs - (Asian Productivity Organisation, 2015). As for productivity, it seeks to broaden both variables so as to provide higher growth in the maximum outcomes of the same resources (Chew, 1988, Mankins, 2017). This is why it is directly linked to performance; for example, with higher labour productivity, more goods and services can be produced with the same relative amount of labour (Prokopenko, 2000, Mankins, 2017).

This operational view addresses reliability problems in production and makes changes visible, but does not tell the whole story (Chew, 1988). How to manage variability

has been a topic pioneered by Deming, who has confirmed this with the 85/15 rule by stating that "85% *of problems can be corrected by changing systems (which are under management control) alone, leaving only* 15% *of problems for workers to control*" (Evans, 1996). Some factors affecting employee performance, such as skills and attitudes, innovation, process itself, technology, equipment and machinery, and demand drivers, are summarized in Figure 2.26.

Nevertheless, specialists have often been trained to concentrate on the technical sophistication and numerical rigour of ratios (Chew, 1988, Singapore, 2011). Too regularly, they bring in practices with great precision while ignoring the real difficulties that managers face (Mankins, 2017). Hereafter, by rethinking this integrative and broader role of productivity, we can say that it considers both analysing its metrics as well as influencing behaviour patterns (Martinez De Ita, 1995, EANPC, 2005, Asian Productivity Organisation, 2014).

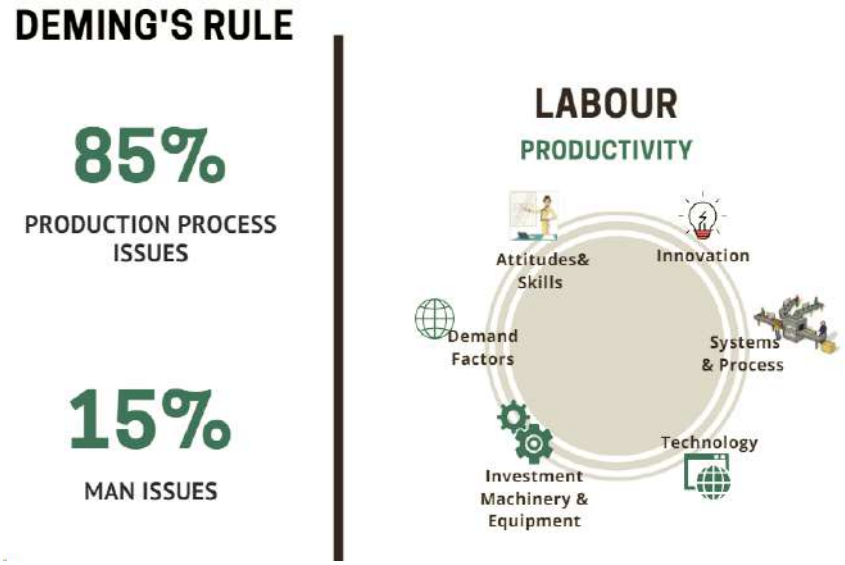

Figure 2.26. Factors affecting Labour Productivity (Singapore, 2011)

This is why what really happens in the company depends on what actually happened in the plant and in the market, not just on the numbers (Mankins, 2017). Performance takes sense when it is a merge of the two objectives defining of productivity, the motivational and the economic (Japan Productivity Center, 1988, JICA, 2011). As for the economic goal, under the absence of growth, efficiency gains are more frequently monetized via cuts in resources, particularly labour force (Singapore, 2011, Mankins, 2017). In lieu of looking at the denominator, executives should instead seek methods whereby the numerator can be enhanced as well as production boosted (Fukuda and Sase, 1994, Asian Productivity Organisation, 2014). However, price fluctuations, obviously, is not the unique significant driver affecting output; quality and value added do have an effect correlated to productivity gains (Shimizu et al., 1991, Anderson et al., 1994, Ohno et al., 2009). Then, with respect to the outputs, they can be calculated either physically (number of clients handled or quantity of printed books) or financially (sales, revenue, or value added) (Atkinson, 2013, Asian Productivity Organisation, 2015). A too restrictive definition of the concept may lead to unwise decisions by subordinates (Chew, 1988).

Assumed this dual tendency, firms must tackle in each side of the equation, upholding the standards not only for planning but also for execution simultaneously and creating clear linkages between them (Mankins and Steele, 2005). That is why productivity is a blend of efficacy (an organization's ability to attain its objectives) and efficiency (the interaction among real and expected performance). Therefore, a multifactorial perspective is important, revealing in particular a need to improve processes and foster teamwork amongst leaders and employees as shown in figure 2.27 (Chew, 1988, Dombrowski and Mielke, 2014). Over this argument, Drucker asserted that "*traditional cost accounting methods are inadequate due to short-term decision need for profits and assure stockholders the return of their investments*" (Drucker, 1995, Watson, 2002). The latter, motivational, comparisons of these indexes may also inspire helpful brainstorming (Shimada and MacDuffie, 1986, Ohno et al., 2009). When the actions being taken are damaging performance, then a new scenario should be developed, whereby the behaviour demanded will turn into gaining solutions (Suzuki, 1993, Morieux, 2011).

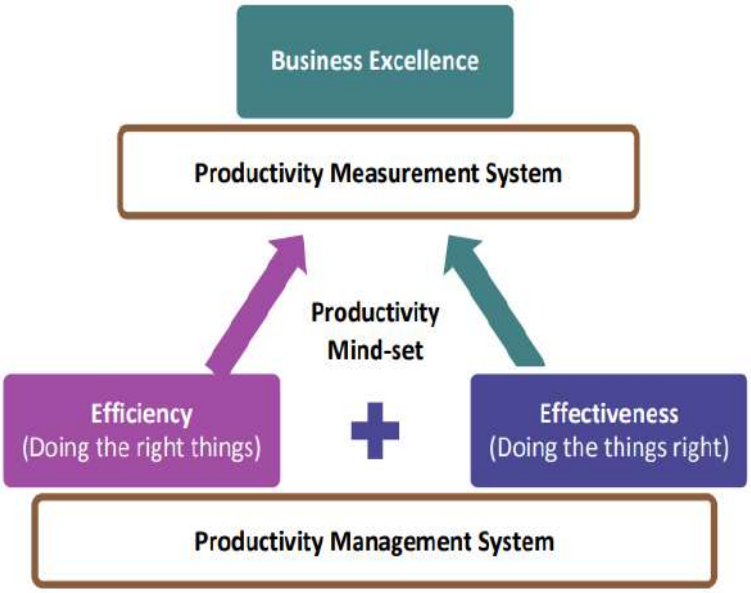

Figure 2.27. Productivity Management and Measurement Systems (Singapore, 2011)

Shifting may involve taking away resources so that people feel compelled to cooperate, giving them more empowerment for decision making, and/or rewarding people who help solve a problem, rather than punishing them when the problem happened (Morieux, 2011, Mankins, 2017). In addition, engineers, supervisors and other office employees clearly contribute significantly to manufacturing productivity, but few measurement systems evaluate the functions for these positions in relation to motivation (Singapore, 2011, Mankins, 2017). This may be supported by Mankins' report (2017) on 300 senior executives from big firms worldwide, who were asked to identify how to unleash the productive power of their teams and accelerate profitable growth. Their results determined what the leadership should recognize:

- Most employees want to be productive, but structures and processes often waste valuable time and impede people fulfilling their duties.
- Few people make a difference and often take on roles that limit their effectiveness. Only visionary leaders ensure that their star pawns are assigned into critical functions.
- People have enormous amounts of energy to devote at work, yet not enough enthusiasm to do so. Executives should strive to match the company's purpose with that of each individual.

Their conclusions were that embracing a productivity mind-set may be challenging, but the outcome is huge. Furthermore, it suggests that the top performers are more than 40% ahead of the rest. This difference results in substantially higher profits - operating margins 30% – 50% higher than those of the industry do - and faster growth.

To conclude this section, it is well known that productivity is critical for the long-term competitiveness and profitability of organizations. It can be increased significantly if managed holistically and systematically. The framework of its integrated management provides a parameter that stimulates business plans and provides the necessary robustness to introduce Lean.

7.2. Bundles of Measuring Lean

Extensive Lean evaluation reports have been undertaken; almost all have provided a variety of gauges and checklists on how to assess change within the current LP implementation. In relation to the importance on measurements, APICS in point 7.3 states that "*Metrics are selected, established, and set for assessment in the early phases of a project, if not immediately. Budgets and financial ratios are used to analyse and assess the ongoing final value of the project*".

An investigation by (Mankins and Steele, 2005) has found that corporations only deliver an average of 63% of the financial returns that their strategies promise. Even worse, the causes of this breach are almost invisible to upper management. The results are wasted energy, wasted time and continuous underperformance. In addition, the financial reporting procedures to assess the long-term financial plans and strategies have difficulties to discern this gap. The findings included no follow-up on performance compared to long-term planning; cross-annual outcomes rarely match expectations and this gap nurtures a culture of underperformance. In short, closing the gap between strategy and performance is a source of immediate improvement and an important driver of cultural change with an impact on the organization's competitiveness. So far, the importance of measurement for strategic planning has been presented; there is widespread agreement among Lean practitioners that its enforcement should be conceived, mapped and evaluated against the attainment of business imperatives (Arteta and Giachetti, 2004, Atkinson, 2010, Taylor et al., 2013).

Nonetheless, Jim Womack, at the 2015 Lean Transformation Conference[10], has been asked about metrics and he has asserted that "*What I have been struck by is the grip of mindless metrics. Organisation is vertical, so you have got all these vertical metrics, so one department metric makes it impossible from other department to do their work. And, then second, the absence of horizontal metrics, though, a want, not as a performance metric, but it is how did you achieve that performance? … The boss is just happy to know that you made your numbers that he not asking any questions. Wait a minute; those are the important questions. How did you do this?…I've just become aware of the grip of the metrics mentality that never starts with the work, but starts at the top*".

High-yield per se is not synonymous with LP success (Bortolotti et al., 2015). Complementing these claims, Emiliani (2000) in Table 2.5 has dealt in detail with this dilemma, pointing out how measures have not been adequately captured in operational practices and attitudes where employees from different departments can be held accountable as a result of their segregated responsibilities. Moreover, to borrow what was determined by (Meade et al., 2010) (see previous chapter, section 3.2.3), initially, LP implementation tends to generate a negative effect on short-term turnover and profit rates due to reduced inventories. Considering, additionally, that only 10% of SMEs successfully deploy Lean, the rate is low (Moeuf et al., 2016). Hence, the fact is that SMEs perceive LP as an unnecessary waste of resources, especially if they do not anticipate immediate returns (Achanga et al., 2006).

[10] www.youtube.com/watch?v=fvNOpILReRY

What the CEO says	What engineering people do	What manufacturing people do	What purchasing people do	What quality people do	What finance people do
1. Double net income	Design products with short supply chains Eliminate long lead-time products/services	Set-up reduction, one-piece flow, kanban, TPM, Kaizen, mistake-proofing, etc.	Limit size of supply base Teach lean methods to suppliers	Teach root cause methods Eliminate defects	Identify ways to re-deploy human assets
2. Increase cash flow by 100%	Design new products with 25% existing production parts	Set-up reduction, one-piece flow, kanban, TPM, Kaizen, mistake-proofing, etc.	Limit size of supply base Consolidate material requirements	Teach root cause methods Eliminate defects	Identify ways to re-deploy human assets Determine root cause of cost variances
3. Increase working capital turnover by 30% per year	Design new products with 25% existing production parts Eliminate long lead-time products/services	Set-up reduction, one-piece flow, kanban, TPM, Kaizen, mistake-proofing, etc.	Limit size of supply base Teach lean methods to suppliers	Teach root cause methods Eliminate defects	Identify cost drivers Determine root cause of cost variances
4. Double inventory turns	Design new products with 25% existing production parts	Set-up reduction, one-piece flow, kanban, TPM, Kaizen, mistake-proofing, etc.	Teach lean methods to suppliers	Teach root cause methods Eliminate defects	Support internal/ supply chain lean production activities
5. Introduce ten new products over two years	Value engineering Design to target costs	Make to demand Kaizen	Know supply chain capabilities	Improve supplier quality systems	Support target cost discipline
6. Develop new products in half the time with half the money	Design new products with 25% existing production parts Use common materials and processes	Set-up reduction, one-piece flow, kanban, TPM, Kaizen, mistake-proofing, etc.	Kaizen purchasing process Teach lean methods to suppliers	Teach root cause methods Eliminate defects	Determine process costs Determine root cause of cost variances Identify cost drivers
7. Reduce costs by 30%	Design new products with 25% existing production parts Use common materials and processes Design to process capability	5S, Visual factory, TPM, set-up reduction, mistake-proofing, standard work, one-piece flow, kanban Kaizen Identify cost drivers	Use target costing Select lean suppliers Source parts in process families Identify cost drivers	Teach root cause methods Eliminate defects	Perform total cost analysis Target costing Identify cost drivers Identify ways to re-deploy human assets
8. Improve product quality by 50%	Use common materials and processes Design to process capability Participate in root cause analysis	5S, total productive maintenance 5 Whys, fishbone, etc. Mistake-proofing Participate in root cause analysis	Select lean suppliers Source parts in process families Participate in root cause analysis	Participate in root cause analysis Eliminate defects	Identify cost drivers Participate in root cause analysis

Notes: The items contained in this Table represent the activities that lean producers typically do, or should do, as a first response to challenging CEO mandates. It does not represent all activities that are normally undertaken. The functional boundaries in Table IX are not intended to be as distinct as indicated in Table VI

Table 2.5. Contemporary Lean: business/process focus (Emiliani, 2000)

The whole supply chain, particularly SMEs, is still hesitant about the cost involved and its likely tangible and intangible advantages (Achanga et al., 2006, Rauch et al., 2017) or fail to align the business in line with the methodology (Lewis, 2000, Kaplan and Norton, 2001a). To illustrate this, Figure 2.28 summarizes in a Pareto chart the results from Rauch et al. (2017) that determine the lack of Lean knowledge among SMEs; there are those who know the methodology, yet have neither applied it nor planned their first projects. Companies already operating Lean just carry it to manufacturing. About 10% of interviewees have already adopted Lean methods for product development.

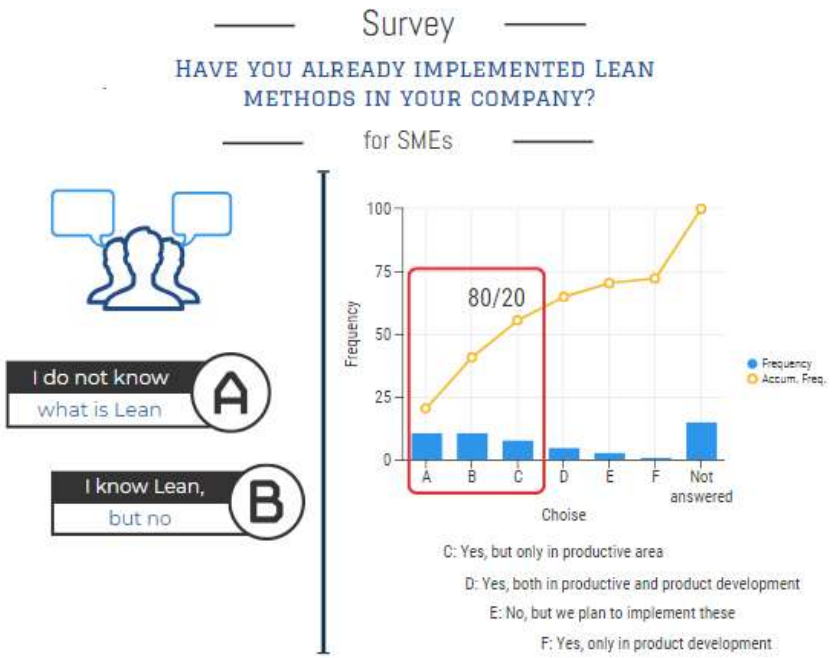

Figure 2.28. Survey results about Lean implementation at SMEs (Rauch et al., 2017)

For some authors, what is more directly evident from the impact of the introduction of different management practices should be productivity, because it bridges the gap between human capital and corporate performance (Powell et al., 2013, Birdi et al., 2008). Now, considering these limitations, according to the author, if Lean claims to waste elimination as an attempt to deliver value to the customer, then to evaluate it, a Value-Added Productivity Measurement (VAPM) should be defined. Seeing these statements, what emerges is the following hypothesis which can be schematized in Figure 2.29.

Hypothesis 5: **Value added Productivity Measurement is a suitable means of assessing Lean performance as a strategy for change.**

According to Spring (2011), the value added entails the wealth generated through the production activity or services provided in-house. Very often, it is applied when measuring outputs in terms of the amount of sales and costs of materials and services produced to generate sales. Such resulting wealth, then, derives mostly from the joint forces of employees and shareholders who provide the capital. Thus, Figure 2.30 attempts to explain that VAPM is distributed for the benefit of all in the form of salaries for employees, amortisation for reinvestment in machinery and equipment, interest

for money lenders, dividends for investors and profits for the organisation (applying the third principle productivity guide, see section 5).

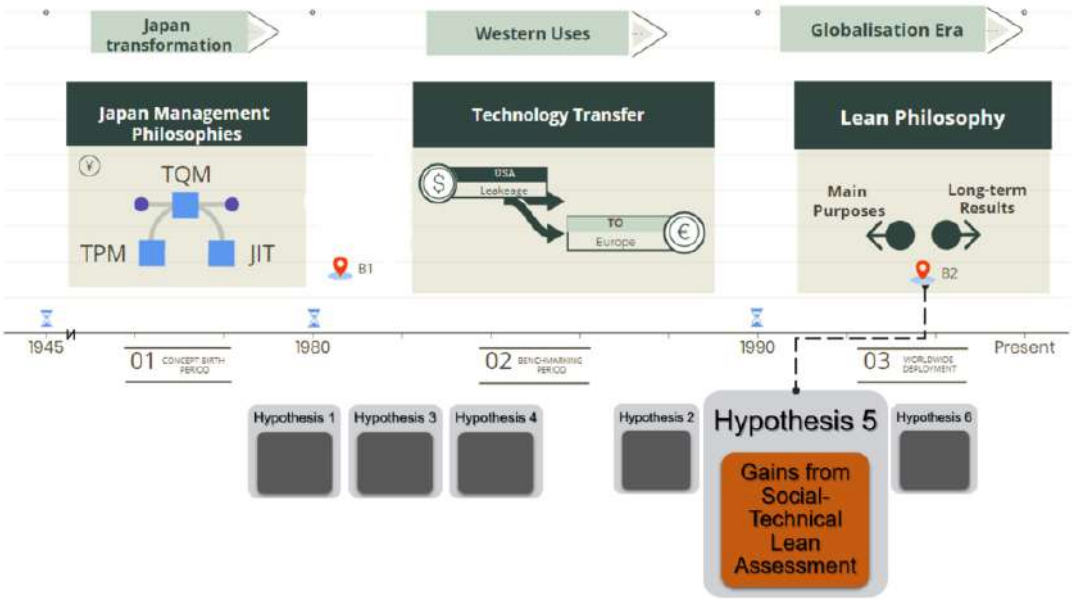

Figure 2.29. Socio-technical assessment of Lean

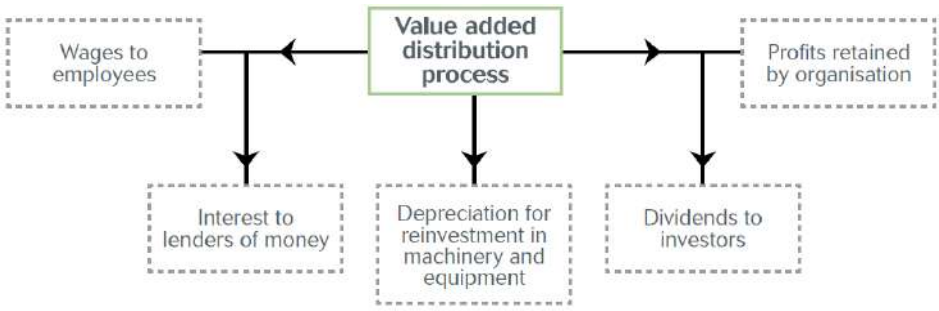

Figure 2.30. Distribution of the wealth created by the firm (Spring, 2011)

Why using value-added as an indicator for measuring Lean strategy? Such an indicator quantifies the net wealth created by the company (actual output), excluding supplies other than those stemming from production or service efforts (Shimizu et al., 1991, Singapore, 2011). In addition, its units are financial, being easy to gauge within both the manufacturing industry (corporates or SMEs) and the service sector (often intangible) (Fukuda and Sase, 1994,Spring, 2011). The greater the value built by collective effort, the higher returns shared by those who have contributed to it (Japan Productivity Center, 1988, Spring, 2011). The value added can be determined by subtraction or addition calculations; Figure 2.31 underlines the elements of both forms of calculation and that either of them obtains the same result (Shimizu et al., 1991).

The first gauges the difference in sales and costs of goods or services purchased to trigger sales.

Value added = Sales – Cost of purchased goods and services

Where : Sales are incomes derived from products sold or services rendered by the organization (excluding miscellaneous and other non-operating income, inventory not produced during that period). Cost for goods and services purchased may include raw materials, supplies, utilities and other services (e.g., insurance, security, professional services) purchased from external sources.

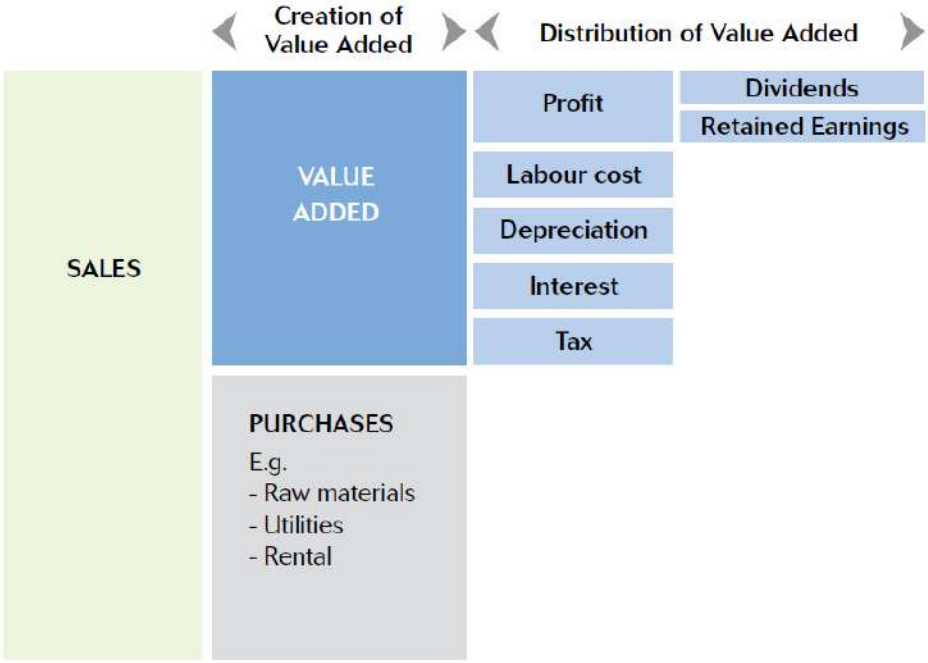

Figure 2.31. Calculation Methods for Value Added (Spring, 2011)

The Addition Method underscores the distribution of value creation to those who have helped to achieve it (Shimizu et al., 1991).

Value added = Labour cost to employees + Interest to lenders of money + Depreciation for reinvestment in machinery and equipment + Profits retained by the organisation + other distributed costs (e.g. tax)

Where: Costs of labour include wages and salaries, commissions, bonuses, subsidies, benefits and employer contributions to pension funds. Interests are borrowing costs incurred for a loan. Depreciation is the value of fixed assets depleted over operating life (including amortisation of intangible assets). Profits are operating income before taxes (excluding non-operating income and expenses). Taxes refers to indirect taxes, excise duties and levies.

In short, Lean is a strategy for change whereby both frontline and supporting staff (such as accounting, human resources or information technology) must be engaged and nurtured (Gunasekaran and Kobu, 2007). Its overall profitability may not be obvious as a consequence of the inherent costs, especially for SMEs, and as it will diminish in the

early stages (due to stock shrinkage) (Meade et al., 2010, Rauch et al., 2017). Certainly, conventional bookkeeping procedures are not suitable for strategic decision-making (Gunasekaran and Kobu, 2007, Meade et al., 2010). Likewise, owing to its socio-technical nature, several papers have hinted at whether performance improvement can be non-linear (Netland and Ferdows, 2016).

Productivity is an objective source of information on long-term operational trends, plus it includes quality of life (Chew, 1988, de Menezes et al., 2010). The Japanese generally give significant weight to productivity management understood as a broader approach (Stainer, 1995, Leandro, 2007). On this basis, for the author, via value-added productivity measurement, as well as the underlying structure of KAIZEN, a synergy is established among multiple practices (tangible-intangible and socio-technical aspects).

8. Conclusions

In this chapter, a series of subjacent hypothesis have been attempted, behind some pragmatic evidences, to give an answer to the problems exposed during the literature review which has exposed some obstacles found in the deployment of Lean, that currently persist today. It has first been found that there were initially unintentional but unnoticed knowledge transfer problems during the Japanese style benchmarking stage towards the USA and then the rest of the world. The concept of holistic productivity was one of those lost aspects along with the concept of Kaizen as the initial basic strategy for the implementation of any JMP, including Lean.

Subsequently, it has also been justified that LP is more than just an aspect of operations management; it includes a whole strategy that also involves the human factor. On the other hand, what is not measured cannot be controlled, under this, Lean consideration is not the exception so it is vital for any business to have a well-defined system of evaluation and monitoring of results that allows to know the performance level, taking into account both qualitative and quantitative aspects. Last but not least, understanding that principles, organizations, people and tools are complementary to each other is what allows to consider Lean as a dynamic and complex system, the interaction between its parts affecting the expected result and which solutions should not be done in isolation (sum of the parts).

So, as it can be seen, the relationships regarding Lean practices are not always clear; normally, practitioners do not agree entirely on which sequence of tools to be used at the beginning. The concepts are sometimes distorted and the links among them are not obvious. Therefore, it is necessary to have a framework at different levels as a guidance to approach the problematic. In the next chapter, the design of a synthesis model will be suggested using loop diagrams. Having Lean architecture in mind, as a system will help to save the intricate nature of its complexity and uncertainty, covering socio-technical dynamics.

Chapter 3

A methodology for applying Lean

Contents

1. Introduction

Following a change in the global business environment, the need for a greater degree of rational adaptability is revealed and correlated both with better planning and operational efficiency of the organisations. That is why competitive strategies (e.g. Lean) must be aligned with a company's strategy and, subsequently, be associated with productivity improvement plans. In accordance with the assumptions set out in the previous chapter, it has already been established how complex it is to introduce Lean initiatives, due to the interaction between its network of components, as well as its socio-technical dimensions. So far, LP has been approached with a local view to address its deployment problems, neglecting the complexity of the relationships among several industrial concerns it may involve. However, the same obstacles remain, as described in the state of the art. Yet, strategic formulation and implementation must be consistent with the overall vision, examining both internal and external factors. To this end, the proposed methodology has been based on the holistic productivity approach linked to KAIZEN, which is articulated together with the value-added productivity measurement. These aspects reinforce the quantitative and qualitative methods by addressing it under a systemic thinking with a long-term vision. In addition, this approach has a multidisciplinary dimension by establishing links between the different domains of the organization as part of a learning organization. Thus, the structure offered by the "*balanced scorecard*" is considered a right platform for building this proposed methodology. This structure offers a logical sequence for the development of Lean strategy in any type of enterprise, but especially in SMEs.

The framework of this chapter presents in Section 2 confronts the challenges involved in Lean by considering it a system of systems. In Section 3, we develop through loops diagrams the analysis of the LP complexity, while Section 4 shows how crucial the value added productivity measurement is for the Lean evaluation is to this perspective. Section 5 focuses specifically on the methodology proposed for Lean using the BSC structure; finally, section 6 presents some conclusions.

2. Confronting the challenges involved in Lean

By stating that *"management of the world has become the new social function; few accept it*", Drucker (2012) has proposed a theory in which he points out that governance has a social function. Hence, leaders must be capable of both integrating and involving people within the corporate culture (based on common purposes and values) (Deming, 1982). Furthermore, the heart of managing business is to ensure productive knowledge, as it is an institution of learning that is conducive to growth and development (Drucker, 2012). As the 21st century unfolds, a more dynamic technological age is emerging with new challenges that seem to be evolving and producing a shifting environment where everything seems to be interconnected (e.g. customer satisfaction, networks and digitisation) (Rüttimann and Stöckli, 2016).

Facing this scenario, the business context becomes more complex; therefore, its management is not a fixed phenomenon - it is not isolated - but rather the organization

must be able to adapt (define longer-term suitable objectives) with flexibility towards fluctuating conditions (strategy) (Drucker, 2012, Gunasekaran and Ngai, 2012). The essence of this belief postulates that how an organization is established influences its behaviour (Kotter, 2007). What this means is a change from attempting to examine and comprehend facts in isolation, whilst being able to respond to the whole context (Berry, 2011, De Langhe et al., 2017). Once again, people are required to have managerial expertise - work and discipline - along with understanding of the business internal structure - objectives, values, environment, market, basic skills, etc. (Drucker, 1999). It implies a high competence level in a variety of different abilities (e.g. humanities, psychology, economics, ethics or physical sciences) (Deming, 1982, Jackson, 2003, Seddon and Caulkin, 2007).

2.1. Systems theory in management

Jackson (2003) has defined a system as a group of interconnected sub-units being able to achieve a general objective. There are numerous kinds of systems to be found in different fields such as ecological, social, biological or mechanical, as illustrated in Figure 3.1 [1], whereby defined by inputs, processes and outputs, which components are constantly tracked. Indeed, a company, a manufacturing line or a business strategy (as in Lean) are examples of systems, as they are assembled upon many functionalities within the cycle of planning, organizing, managing, coordinating and controlling to jointly generate a given product/service in order to achieve expected profits (Seddon and Caulkin, 2007, Kasser, 2015).

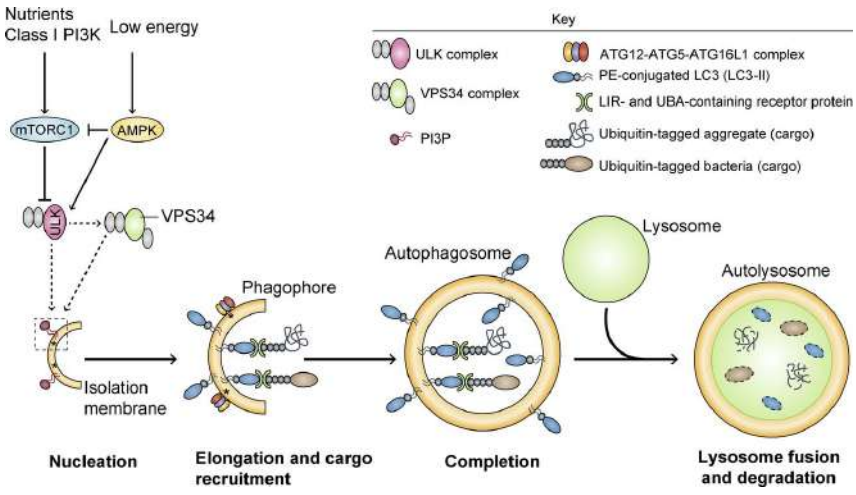

Figure 3.1. Example of a biological system. Protective roles of autophagy.

However, if part of a system is withdrawn, then its original scope is distorted. It has been acknowledged that the traditional scientific method for studying problems has been reductionism, wherein the attitude of the elements towards the whole is investigated. Consequently, the outcome is a linear correlation between a cause and an effect (Jackson, 2003, De Langhe et al., 2017). Groves et al. (2007), who have defined linear thinking as a tendency to look for the external, tangible dataset and facts, then

[1] http://jem.rupress.org/content/212/7/979.figures-only

treats such information via logical cognizance and rational reasoning towards shaping understanding or a decision to drive further action. As examples, if a rack of books alone can hold about 50 - a doubled length can hold 100; or if the sales have been poor (effect), then what can be inferred is that the selling department is not motivated enough (cause) (De Langhe et al., 2017).

In the opinion of de Langhe et al. (2017), there has been intensive exploration by cognitive psychology into the human brain as it strives to capture the nonlinear ties of its environment whilst giving easy linear solutions; often such thinking seems to work fine. The difficulty is often when the whole can be the product of an unrecognizable way in how the parties arise (Senge, 1991, Jackson, 2003). Nonetheless, numerous largely non-linear scenarios do occur inside businesses, where a differentiated perspective of problems is critical. Obviously, the attitude/behavioural pattern is non-linear (Emiliani, 2000, De Langhe et al., 2017). As an illustration, there is a non-linear trend towards the nexus around how customer satisfaction ratings align with customer retention (Groves et al., 2008).

Another case: the traditional organigrams are simply hierarchical structures without being indicative of action, workflow nor interaction. Key elements of the value chain (suppliers, customers or the market) have not been integrated into the organizational charts, yet they do have an impact on the entire organizational system (Jackson, 2003, Bicheno and Holweg, 2016). Often, top echelons fail in their decision-making when linear setting is suggested, without considering how all the elements involved interact (Bortolotti et al., 2015, De Langhe et al., 2017). Such learning is difficult in companies that manage by results based on a reductionism reasoning (Senge, 1991, Seddon and Caulkin, 2007). Likewise, the same is valid for Lean, which has been addressed as the dissemination of a "*recipe*" (Rüttimann and Stöckli, 2016).

On the other hand, facing a different competitive reality is characterized by high uncertainties, fast changes and rapid reactions with limited information; complexity management offers an alternative perspective to reductionist methods (Jackson, 2003, Groves et al., 2008). Thus, Seddon and Caulkin (2007) have defined a Complex Systems as a set of many sub-systems organized hierarchically to reach the common goal of the whole system. Accordingly, one system becomes a very dynamic phenomenon having five important features: (a) any system is defined by an arbitrary boundary within its environment; (b) inputs disrupt its environment onto the system; (c) intrinsically within the system, inputs interrelate during a transformational process; (d) inputs processed come out as outputs and (e) the flow direction gives the stream of materials, information, energy, etc. For Groves et al. (2007), non-linear thinking refers to as a tendency to attend to inner feelings, sensations and impressions. Processing such information (consciously and unconsciously) uses intuition, creativity or wisdom to shape knowledge, awareness or a decision for further action.

In addition, in the systems theory vocabulary, the notions of control and communication are important; accordingly, there is a positive (self-reinforcing) or negative (self-correcting) adjustment or feedback to the environment (Cusins, 1994, Jackson, 2003). With this concept, a proper and logical analysis can be made of intentional behaviour, i.e. behaviours towards the achievement of a goal, using a social structure like that at a company in order to allow people to learn (Senge, 1991, Seddon

and O'Donovan, 2010). Hence, the system must be controlled. To understand it, the idea of negative feedback is crucial to capture any deviation in conduct from a given objective and to carry out mitigation actions, based on this information, to bring the behaviour on track into the target (Senge, 1991, Jackson, 2003). In Figure 3.2, Jackson (2003) has shown a simple system of negative feedback. Its functioning relies on detecting the current output of the process to be controlled. It is compared to the desired objective and, if it varies from it, the input is fixed back to achieving the desired objective. In this way, the systems organise and control themselves, in presence of environmental disturbances, via information sharing. Identifying situations where parts of a system are locked in a positive feedback loop, and their behaviour is spinning out of control, is obviously important to managers.

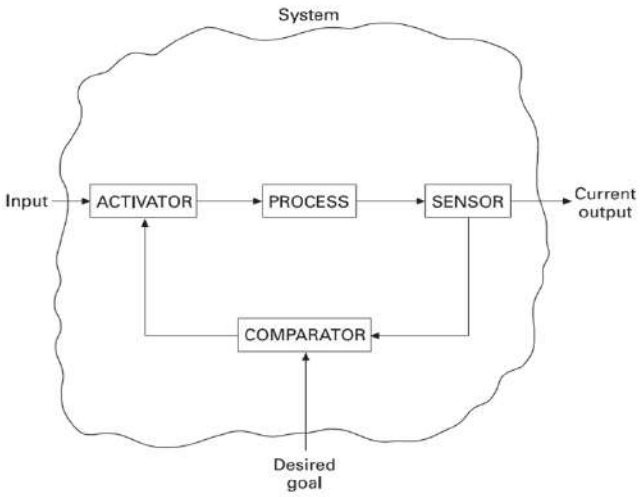

Figure 3.2. Example of a negative feedback system (Jackson, 2003)

Systems theory may contribute greatly to Lean and entrepreneurial thinking, since it offers a straightforward manner of examining the correlation among each of the parts of a system and their feedback (positive or negative) (Senge, 1991, Cusins, 1994). In addition, Gunasekaran and Ngai (2012) presented a research about the future of Operations Management where they suggest that in an industrial practice, companies? priority must be given by factors that are both internal and external to them. Then, they highlight the weight of flexibility within a competitive strategy concentrated on developing sociotechnical aspects, like Lean. Therefore, the dependence in human factor has both advantages and risks that determines the performance of any system, which requires an extremely dynamic and adaptable environment (Evans, 1996, Bhasin, 2012).

2.2. Systems theory in management

Edward Deming [2] (1982) has suggested the practical means of running a business as a system, by claiming that *"A system cannot understand itself. Understanding comes from outside. An outside view provides a lens for examination of our present actions, policies... Knowledge from outside is necessary. Knowledge from outside gives us a view of what we*

[2] http://jem.rupress.org/content/212/7/979.figures-only

are doing, what we might do, a road to improvement, continual improvement. By profound knowledge, I mean knowledge from outside".

According to Evans (1996), Deming has emphasized that to maximize performance within a process differs from operating it so as to achieve full benefit to the whole system. Assigning responsibility for specific results to individuals or areas becomes much easier inside a company. In most cases, however, the efforts to engage people beyond what they believe to be their responsibility are weak and centred on optimising their own particular interests. The governance structure often determines how the people working in it are organised. The lack of teamwork is the result of the way the culture has been built in the organization. When it comes to modifying attitudes, the whole management system must be considered, not just its elements.

This is why Deming called his theory "*System of Profound Knowledge*", which discusses for the first time the perspective of a different management approach considered as a system, in reference to the theoretical explanation of complexity (Seddon and Caulkin, 2007). This theory is grounded upon the fact that there are four interdependent aspects involved in it, as illustrated in Figure 3.3 (Deming, 1982):

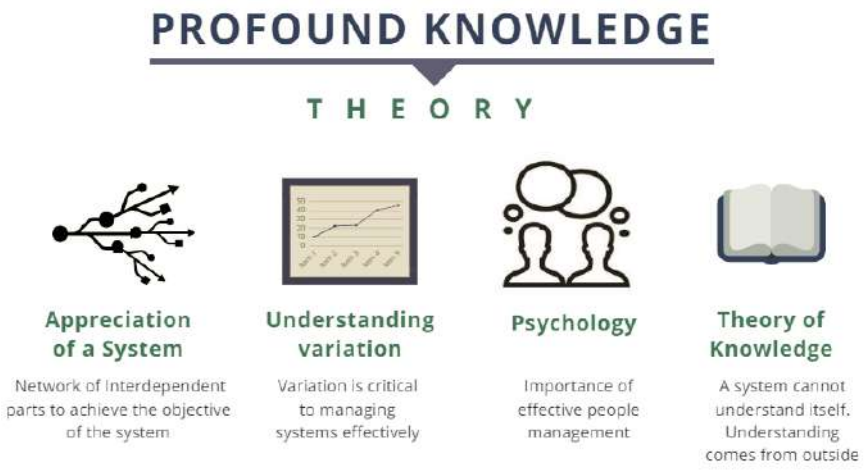

Figure 3.3. Theory of Deming about complexity (Deming, 1982)

- **Appreciation of a System**: a system is complex, as "*a network of mutually dependent parts working together to try to achieve the objective of the system*". Partial optimization does not optimize the whole; therefore, coordination and cooperation of the parties through appropriate leadership are required. A leader must understand what he is trying to manage and understand the interconnectedness and interdependence of the orchestrated parts in order to achieve the objective of the organization. First, he has to establish the aim: vision, mission, goals or constancy of purpose of the system (Berry, 2011). The traditional philosophy of "*management by objectives*" has failed to articulate each component within this interdependence, leaving each one to do a separate job. This means seeking your own reward by destroying the balance of the system (Seddon and O'Donovan, 2010, Berry, 2011). On the contrary, each person must understand his work, know how to do it well and be aware of the interaction with the rest of the system (Evans, 1996).

- **Understanding variation**: variability is a natural and unavoidable part of life. There are two types of variation that arise from common causes inherent in the process design, such as defects, errors, mistakes, waste and rework (in a stable system, this will be predictable within certain limits) and something special that represent a unique event that is outside the system. The aim of the system is to reduce the range of fluctuation over time, as well as to adjust the flow setting to the desired level. The expertise gathered from this study of variability must be embedded into the ongoing efforts for enhancement via a continuous improvement cycle. This consists of planning and studying the data to foresee a solution, applying the changes, checking closely the resulting effects with the desired ones and carrying out measures to fully implement these modifications (Berry, 2011).

- **Psychology of change**: a company is a complex adaptive system tailored around its identity (vision, purpose, guiding principles, values, history, success theory and shared aspirations). This identity must be clearly designed and shared in accordance with the people, who are the source of value. The worker is motivated mostly by intrinsic requirements (self-esteem, desire to learn, creativity and joy in accomplishment, and a need for freedom and belonging), as opposed to just a monetary reward. Resistance to change is often strong when everyone has a feeling of being devalued, but this is diminished when everybody shares the identity and grasps the advantages of transformation. As people adapt and develop new skills, they feel that their potential increases, and they empathise with change. Giving people a certain degree of control over their work satisfies the need for freedom and gives them the opportunity to rejoice in their work. This requires a new style of leadership.

- **Theory of knowledge**: a system is not able to understand itself, meaning that the system's development relies on the ongoing review of the organization. Deming advises against misleading information with knowledge. Knowledge unfolds by applying theoretical concepts which provide a frame of reference for seeing the situation and giving meaning to the experience. Theoretical forecasting lays a foundation for planning a course of action. Information without the PDCA cycle fails to generate learning or cognizance nor improve the process.

The enhancement consists in acquiring and expanding knowledge about the system. However, decisions are generally done reactively. This leads to another reactionary behaviour leading to an unbalanced effect on the system. A reactionary organization is incapable of operating based on a theory of knowledge because it uses a short-term cycle that does not give the possibility of testing the influence of an action upon any other component of the structure. In this sense, Deming had called attention about this by alluding to the deadly diseases of Western management that impede the ongoing transformation (Berry, 2011):

- Failure to be consistent in planning the scope of a market's product and service, which will hold the company in business while generating jobs.

- Underscored concern for short-term gains from fear of an unfriendly acquisition and pressure from bankers and owners for dividends.
- Evaluating the performance, scoring of achievements or annual monitoring.
- Mobility of management and change of job, which could lead to a disruption of continuous improvement efforts as new leaders are added. As a result of the leadership changes, the managerial philosophy becomes different.
- Use of visible figures just for management, giving few or no consideration to the figures who are unknown or unknowable.
- Excessive medical costs (at the firm level and the state/national level). The cost of medical care for employees was among their greatest total expenses.
- Excessive warranty-liability costs, fed by attorneys who receive contingency fees.

Once enquired into these theories, it is not surprising why the JMP has so much in common with Deming, as it was designed based on his philosophy. Deming's legacy has been well expressed by Shoichiro Toyoda, Honorary Chairman and CEO of Toyota: *"There is not a day goes by that I do not think about what Dr. Deming meant to us. Deming is the core of our management*" (Berry, 2011). Hence, it is important to recognize the human nature of the individuals within a company (Drucker, 1999, Berry, 2011). Then, it becomes necessary to look back at Toyota and delve deeper into the overall purpose of its system to try to understand the difficulties that Lean has had.

2.3. Seeing Lean as a system of systems

Attempts to merge leadership into business models have not been successful in the past, due to the fact that the underlying tenets behind them often rely on old-style approaches designed to decrease the consumption of resources, resulting in the workers suffering the consequences (Emiliani, 2000, Carder and Monda, 2013). About this, Carder and Monda (2013) have specified that "*A leader understands how his group's work fits in with the company's objectives. A leader is customer-centric, external and internal*". In addition, an inherent problem of numerous firms is that they are trying to implement change into a pull system (Lean/TPS) but still think (manage it) as push system (Atkinson, 2010).

Without a doubt, JMPs have been acknowledged for their style given the complementarity of theories based primarily on productivity and quality and they are still valid today (Holweg, 2007, Murata and Katayama, 2010, Furlan et al., 2011). Likewise, TPS represents a challenging pattern of logic rooted in both design and work orientation, which has been explicitly demonstrated in its commitment to respect for people and continuous improvement as the cornerstones of its philosophy (Liker, 2005, Gunasekaran and Ngai, 2012).

Whilst, even though many respectable U.S. corporations do have respect for people and practice Kaizen together with other tools, what matters is having all the elements

together as a system (Gunasekaran and Ngai, 2012). In this regard, Berry (2011) said, "*Surprisingly, the lack of a clearly defined purpose is common in US organizations*"; owing to a short-term focus over the outputs (quarterly/annual reports) which has brought the monitoring necessity for rapid measures to be taken. As well, Alec McCullie[3] , Associate Director and UK leader of Industry 4.0 at KPMG, remarked that "*Gaining experience with industry 4.0 technologies is certainly important. But, the real value of industry 4.0 comes, not from the component technologies or capabilities, but rather through smarter processes that integrate automation, data, analytics, manufacturing and products in a way that delivers unique competitive advantages and unlocks new business and operating models. And this cannot be accomplished without achieving larger scale, greater integration across functions and a willingness to disrupt the status quo*".

Even though the pillars of Lean are neither tools nor waste reduction, yet with time, some practitioners have restricted it to a mechanical and superficial way of using tools such as Kanban and queuing control (Emiliani and Stec, 2005). Moreover, Seddon and Caulkin (2007) have highlighted that LP has become a cost-cutting and labour reduction programme undertaken by many managers. These tools applied herein merely reflect the logical patterns inherent beneath a system, which are built around system failures. Here, Ohno (2012) has also pointed out that *"Companies make a big mistake in implementing the Toyota production system thinking that it is just a production method. The Toyota production method will not work unless it is used as an overall management system. The Toyota production system is not something that can be used only on the production floors. The belief that it is only a production method is fundamentally wrong . . . those who decide to implement the Toyota production system must be fully committed. If you try to adopt only the good parts, you will fail"*.

Something is remarkable is the linear way in which these Lean barriers have been addressed: the value-added components are improved in isolation, without addressing the whole process. This may not improve the results at all (Gregory, 2007). High performance per se is not synonymous of LP success (Bortolotti et al., 2015). Amidst the findings mentioned above, numerous companies have experienced the same barriers behind the launch of Lean since the 1990s, perhaps caused by a certain static mode of dealing with it. As Womack[4] complained, "*in the Lean Community I detect a growing quietism –an acceptance of things as they are without attempt to resist or change them...Yes, after so many years, I am disappointed in how far we have gotten in spreading Lean thinking. The task of yokoten (best practice sharing) has barely started, and, as a community, we will need to rethink our tactics, stick to our purpose, and better understand the challenges preventing us from staying on course*". LPs are not stationary rather complex and dynamic scenarios aimed to stimulate a momentum for change (Bicheno and Holweg, 2016). Confronted with this situation, both Systems theory and Deming's reasoning applied to management fosters another alternative approach to traditional methods (Cusins, 1994, Jackson, 2003). The transformation sought by Lean occurs not by tools alone but by collaborative behaviour combined with the interrelated and interdependent parts of the guiding principles, people, tools, sub-systems and outcomes(Bicheno and Holweg, 2016). In this sense, Seddon and Caulkin (2007) expressed that "*The Toyota Production System is probably the most highly*

[3]https://www.electronicsweekly.com/news/business/industry-4-0-not-reaching-factory-floor-2017-06/
[4]http://planet-lean.com/jim-womack-on-where-lean-has-failed-and-why-not-to-give-up

developed, best articulated, and most successful examples of systems thinking applied to business organization in the world over the last 50 years".

Given all this evidence, the author believes that many challenges remain, especially during the implementation of Lean that must be treated as a complex system. This is why it seems that Lean responses cannot be motivated by a simple sum of the parts alone but rather through an evolving behaviour. Then, the next hypothesis is submitted and can be seen schematized in in Figure 3.4.

Hypothesis 6: **To solve its bundles, Lean must be addressed as a system of systems**.

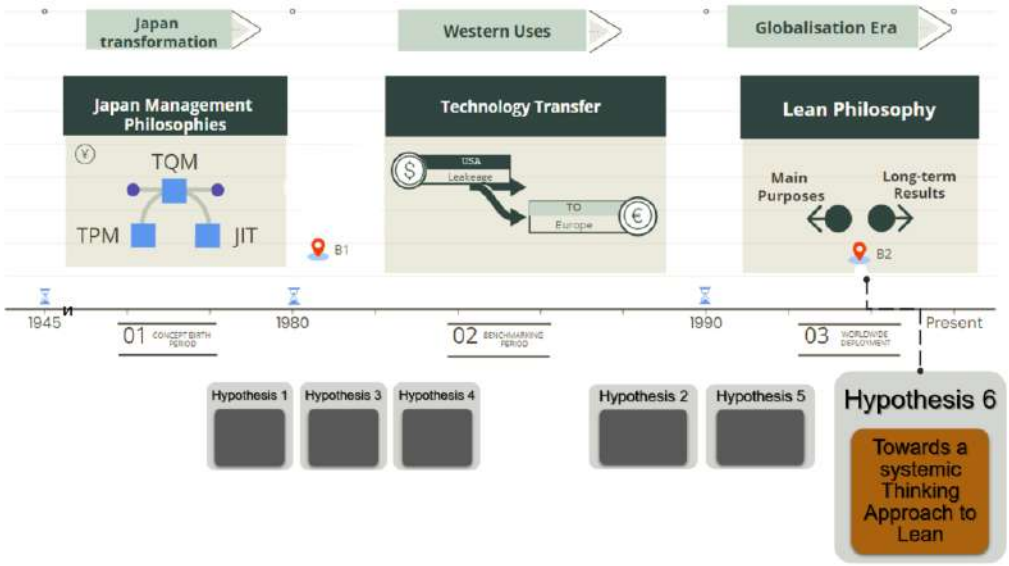

Figure 3.4. Lean is a system of systems

Besides, the different settings and constraints of the structure of Lean may seem complicated without the right tools to analyse and comprehend it. This is why the synergy among System's Theory and Profound Knowledge should be incorporated, giving a broader scope within which variation and problem solving can be better understood. Together, they provide non-linear and punctual behavioural assessments through feedback loops. This will be developed in the next chapter.

3. A Lean strategy: building a complex managerial system upon Productivity

Systems thinking gives valid instruments for a further analysis into management pitfalls (Jackson, 2003, Seddon and Caulkin, 2007). Particularly in the case of Lean, when confronted with application constraints, the tendency has been to treat them as isolated events and tackle their causes one-by-one. Rather, a systemic perspective adopts an alternative view, whereby the intrinsic system structure often engages in external scenarios that generate disruption, entailing socio-technical linkages (Emiliani, 2000, Groves et al., 2008).

As a consequence of looking at Lean as a system of systems, a generic picture emerges by using loop diagrams allowing the LP patterns outlined above to be explored in the light of how their components interact. In level 1, emphasis is placed on the links between the company system and the environment (market). Next, level 2 presents the interfaces stemming in particular both from the organisational sub-system within the enterprise as a whole. Lastly, at level 3, a Lean system interface into the Kaizen subsystem is outlined as essential for the behavioural transformation demanded by a learning organisation.

3.1. Seeing Lean as a system of systems

In one system, the attention is placed on the process instead of the outcome. If the process becomes clear, the result will be better. What is most important is how the components function together (Morieux, 2011, Carder and Monda, 2013). Figure 3.5 displays a macro-level analysis of Lean where it considers at a glance the way the business engages externally into the market. Evidently, when a firm's competitiveness is enhanced, then it should gain market share; and so, having a higher market implies more customers and more profits. This is described in detail as follows:

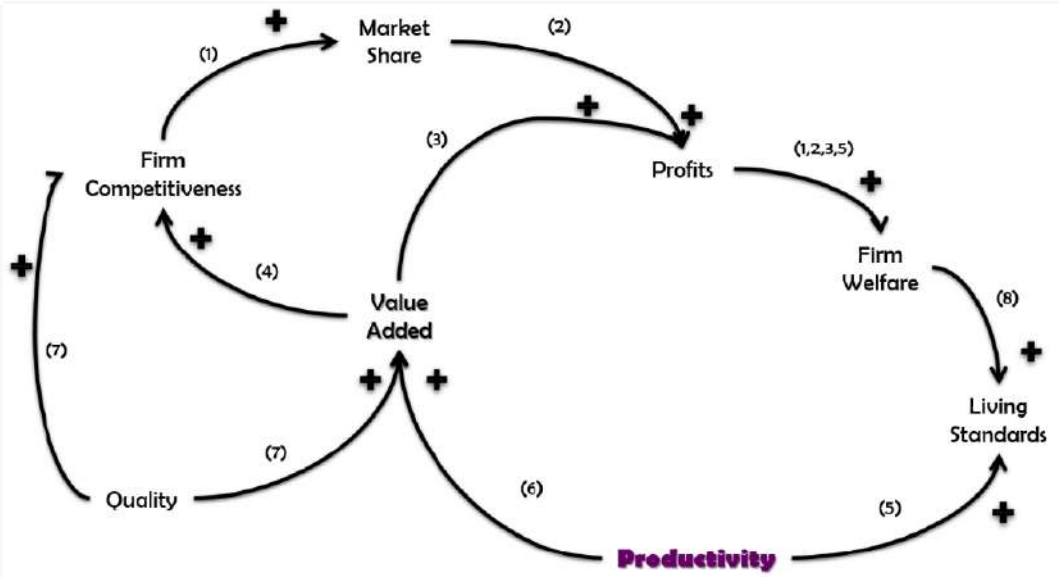

Figure 3.5. Loop Diagram Macro level analysis of Lean; level 1

1. There is a positive connection between market share and competitiveness. Companies struggle to broaden their market share to meet the demands of a global environment; the most successful way for a nation to grow and prosper is by enabling its market to compete (EANPC, 2005). In a firm, there are five forces behind the competitive advantage: new competitor threats, alternative products/services, supplier and purchaser interaction and the capabilities developed by current competitors (Porter, 1996).

2. With the increase in market share, profitability rises. Porter has stated that "*At a firm level, a firm can function, produce and trade in any market, except for certain restrictions. The quantification of its competitiveness is market share and profitability*" (Snowdon and Stonehouse, 2006, Porter, 2011).

3. By creating value into the goods/service, revenues would be higher. Offering more degrees of differentiated goods or services for which the clients are determined to pay (or Value Added) will be reflected in higher yields and so profitability (Porter, 1996, Singapore, 2011).

4. Greater added value to the product/service enhances competitiveness. As Drucker has quoted, "*The purpose of a business is to create a customer..., and is an organisation that adds value and creates wealth*" (Watson, 2002). An undertaking's competitive advantage thus derives either from its ability to operate within its market or by distinguishing itself from what it offers (Lewis, 2000).

5. As productivity improves, living standards rise. In the context of a holistic notion of productivity, it is clearly critical to competitiveness and wealth (EANPC, 2005, Asian Productivity Organisation, 2015, Gunasekaran and Ngai, 2012). About this, Porter has declared, "*Competitiveness is best understood in terms of the productivity with which a Nation can use its resources. If you are productive, you can support a high standard of living or high wages... Competitiveness equal Productivity*". He has continued "*...Prosperity depends on Productivity. Unless you driving productivity up all the time, unless you getting better and better and producing more and more value with every day of work then you can raise your standards of living. This is the iron rule of Prosperity; you earn your Prosperity by Productivity*" (Snowdon and Stonehouse, 2006).

6. Productivity and value added (VA) together have a positive and direct nexus. A systemic productivity bypasses competitiveness (enterprises) and standard of living (stakeholders). Once productivity is increased, further benefits will be achieved towards better welfare at all levels (Guiding Principles) (Asian Productivity Organisation, 2014). Porter has pointed out that "*competitiveness is determined by the productivity with which a location uses its human, capital, and natural endowments to create value*" (Gunasekaran and Ngai, 2012).

7. From the perspective of the company structure, quality and productivity are clearly essential, since their strong connection impacts directly on added value (Fukuda and Sase, 1994, Hirano, 2009). Together, successful outcomes can contribute significantly to customer and employee satisfaction (Fukuda and Sase, 1994). Therefore, their loyalty will be safeguarded, meaning higher earnings (Deming, 1982).

8. When the company grows, its success contributes to a better lifestyle for everyone involved. In the eyes of a company whose customers are satisfied and faithful, that translates into high ROI rates (Asian Productivity Organisation, 2015). Shaping these demands into internal needs is mandatory for customer satisfaction, as opposed to that of competitors' customers (Patel, 2016). On this basis, a business is conceived primarily for adding value to all stakeholders (shareholders, workers, customers, etc.) (Japan Productivity Center, 1988).

3.2. Level 2 –Middle Loop Diagram

Next, the second level of analysis has a socio-technical angle in mind, whereby the motivational aspects of the human factor must be considered within a learning organisation driven by Lean. In Figure 3.6, it is specified how LP starts from a bottom-up perspective and how both Quality and Productivity (integral) are once again the backbone of this strategy: (Morieux, 2011, Carder and Monda, 2013):

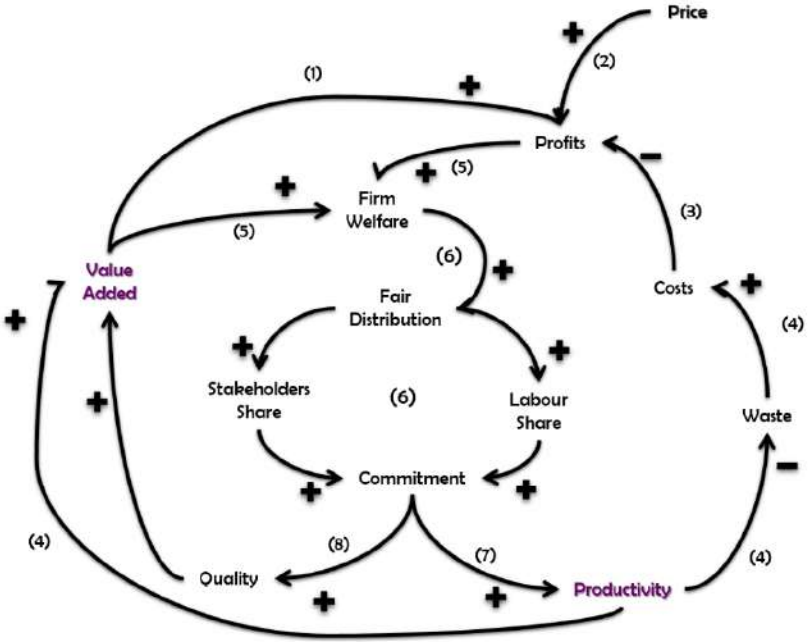

Figure 3.6. Loop Diagram Middle level analysis of Lean; level 2

1. More added value means higher gains. On a business scale, value added is commonly perceived as one of the metrics for outputs as well as a wealth generated via their business operations (Shimizu et al., 1991, Spring, 2011). As already discussed, differentiation is a capacity for adding unique and enhanced value to the customer, thereby allowing the market to pay the price for a product or service.

2. More expensive prices equal more profits. For Porter (1996), the strength of the five competitive drivers influences economic returns via price, cost and investment. So, one way to have a competitive advantage is to increase prices; instead it is better to provide more value than to have prices up, since it is the market who fixes them (Hirano, 2009, Ohno, 2012).

3. Cost cutting is inversely proportional to the benefits. Unlike point 2, the other way to gain a competitive advantage is to reduce costs, which means producing products with fewer inputs compared to what competitors require (Porter, 2011). Accordingly, under the demand and supply law, the market sets prices, so companies have no control over them; conversely, they do control their costs by eliminating entropy (waste) (Ohno, 2012). Drucker has affirmed that "*Yet the cost that matters most for competitiveness and profitability is the cost of the total process,*

and that is what the new activity based costing records and makes manageable" (Watson, 2002). For the same reason, the costs are also inversely proportional to the benefits.

4. The rise of waste has a direct impact on costs and, in contrast, an upward trend in productivity suggests a fall of waste whilst delivering more value. In either case, Productivity (as mentioned previously) assumes central importance in supporting value and costs (Suzuki, 1993). Therefore, production process entails another kind of profitability; once productive, waste is removed and so the cost will be minimised (Leandro, 2007, Ohno, 2012).

5. Adding value generates welfare to the business. Drucker has held that "*since a business enterprise is an organ of society. There is only one valid definition of business purpose: to create a customer. Business is an organisation that adds value and creates wealth*" (Watson, 2002). He is certain that companies will only survive if they are able to meet their future demands, whilst generating value for clients as well as equity for stakeholders (Drucker, 2012).

6. While an asset offers value to clients, the organization benefits by contributing to the general welfare (Japan Productivity Center, 1988). This value-added factor should allow for an even distribution (e.g., in employee salaries, interest on reinvestment of assets for cash lenders, returns to investors and corporate profits) (Shimizu et al., 1991). Wealth comes from the joint efforts of shareholders, managers and workforce; thus, welfare should be allocated fairly according to their contributions (Spring, 2011)

7. The productivity will grow if everyone involved is more committed. Benefits sharing depends directly on productivity performance, and it is embedded within labour participation (EANPC, 2005). Besides, fair distribution builds a strong nexus to morale and commitment regarding both quality of life and standard of living (Sen, 1977, Porter, 2011).

8. Through greater commitment, quality improves. Long-term profitability is influenced positively by quality (Japan Productivity Center, 1988). Once more, the interface of both productivity and quality delivers significantly added value for meeting client demands (Fukuda and Sase, 1994).

3.3. Level 3 –Operational Loop Diagram

Under the systemic understanding of productivity (the Japanese meaning), this approach allows the alignment of the system's objectives (vision, mission, goals) as well as the merging together of its elements, processes and interfaces with the whole (connectivity) (Deming, 1982, Berry, 2011).

On this, Drucker has declared that "*Without productivity objectives, a business does not have direction. Without productivity measurement, a business does not have control*" (Asian Productivity Organisation, 2015). Given these tenets, the third level - operational - of Lean deployment is detailed in Figure 3.7.

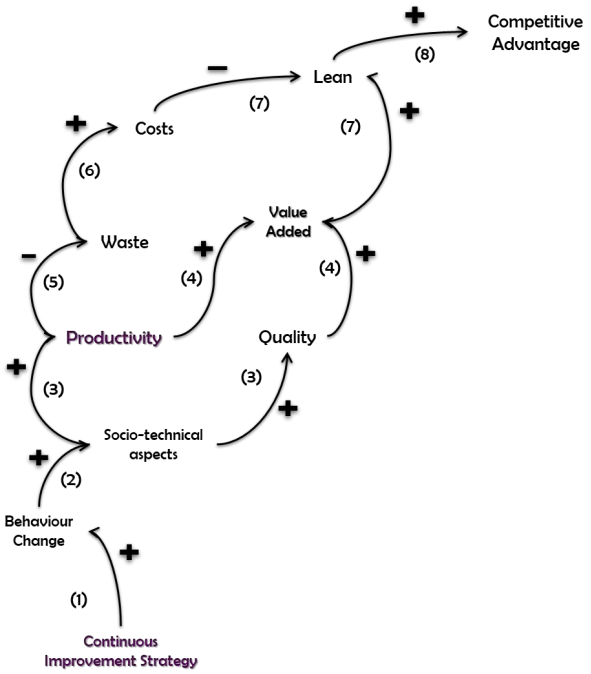

Figure 3.7. Loop Diagram Operational level analysis of Lean; level 3

1. Through continuous improvement, the cultural change required by Lean begins. Guided by holistic productivity as the cornerstone of the entire JMP (JICA, 2011), the KAIZEN strategy (explained in detail in the previous chapter) is then introduced, with an initial orientation towards the application of participative promotion practices (Suzuki, 1993, Fukuda and Sase, 1994). Furthermore, the need to optimise processes is undermined by the joint endorsement of both managers and collaborators (Ohno et al., 2009, Ohno, 2012).

2. Behaviour change enhances socio-technical dimensions of Lean. As both de Menezes et al. (2010) and Birdi (2008) have noted, operations management (tools and techniques) is directly tied to human resources development practices. Moreover, the role of people is paramount with regard to the environmental and cultural conditions that depend on them; this renders motivational awareness an explicit force for engagement, and both encourage a high standard of productivity and quality (Fukuda and Sase, 1994).

3. Both operational and human aspects directly affect productivity and quality. The Asian Productivity Organization (2015) has established that if KAIZEN's strategy is well structured and built on systemic productivity, the employee's behaviour evolves gradually via the everyday use of kaizen instruments. However, at the beginning, it is needed to be patient, since the results are often intangible and rather costly (Bhasin, 2008, Meade et al., 2010). It is also coherent to conceive it as a strategic business philosophy involving organizational change; cultural behaviour prepares a path for a toolbox perspective (Melton, 2005, Bortolotti et al., 2015).

4. Quality and productivity together create value to the customer. When the business is taken on as a system, it is composed by three elements: inputs, processing and outputs. Under this scenario, the synergy that exists within

productivity and quality eventually delivers greater levels of yield over the whole and builds customer value (Chew, 1988, Fukuda and Sase, 1994).

5. Productivity has a negative correlation with waste. According to Deming (1982), variability phenomena within the production process must be tackled, as 85% errors are due to deviations from the system, whereas 15% are caused by labour. Besides, productivity evaluation helps as effective communication vehicle for exchanging current performance against the objectives defined. Simultaneously, it offers a goal-oriented framework for acknowledging and rewarding team and individual achievements. Likewise, it can determine the further needs to develop and train personnel for waste mitigation (Asian Productivity Organisation, 2015).

6. When waste becomes bigger, costs rise. Waste is a non-productive activity as it does not add value to the product; therefore, a cost-oriented strategy means addressing the different types of waste (as mentioned in the preceding chapter) (Suzuki, 1993, Takemura, 2002). For this reason, a system must be tailored to ensure maximum benefits derived due to given patterns of variation (Deming, 1982).

7. The value added often determines how productive a company has become and helps to quantify its outputs (Shimizu et al., 1991). Thus, it is important to develop systems to maximize benefits owing to some forms of variance (Deming, 1982). Accordingly, the focus should be on achieving a customer-oriented environment that balances cost-benefit and customer value (Hines et al., 2004). Costs ought to be lowered to a minimum rather than budgeted, leading towards consistent efforts to control them (Porter and Michael, 2001, Ohno, 2012).

8. The Lean Enterprise Academy (2016) acknowledges Lean as an innovating business approach for creating value to customers and eliminating waste. A primary goal for LP is to provide an organizational platform for behavioural change for achieving a competitive advantage and thereby boosting business performance while maximizing profits. In this manner, a company becomes profitable if the value surpasses the associated costs incurred during operations and, therefore, it will be able to attain a competitive advantage against its competitors (Porter, 2011, Gunasekaran and Ngai, 2012).

Bearing in mind the premises described above, in order to determine the evolution of the Lean system within any organization, particularly SMEs, various categories of key metrics are required that allow the full panorama of its operation. Therefore, the baseline that offers productivity under its systemic vision constitutes the cornerstone for assessing LPs. As such, it emphasizes the strategic operational dimensions associated together in order to show how they interact in the overall performance.

4. An Integrated Approach to Productivity Measurement

Using accounting measures such as unit cost or asset utilization focuses only on an isolated part of the value chain (Emiliani, 2000). Disregarding the complexity of

business as a system, the accounting improvement is limited to shifting costs to another department rather than improving the overall outcome (Katayama, 2017). On the other hand, the productivity evaluation process is a necessary condition, not only for performance analysis but also for formulating a strategy as well. APICS, in section 2.1.10, has bring up about Operations metrics are a quantitative indicator for process change, showing improving, maintaining, or declining performance. There are two levels of measures within operations functions: top-level key performance indicators that indicate if a process is starting to get out of control and diagnostic measures used for problem solving, process improvement and data analysis (Castle and Jacobs, 2011). Traditional profitability ratios are suitable, but they must be linked to productivity, as profitability is influenced by efforts towards productivity growth. For that reason, this section contains a set of mixed metrics to measure business performance and to strengthen decision-making (Shimizu et al., 1991). Furthermore, studying the behaviour of productivity rates over a given period of time as a diagnostic tool will reveal problem areas that require immediate attention and will help to emphasize those of higher priority (Spring, 2011). At the LP implementation scale within a holistic productivity view, the objectives are based on the organization's overall goals; then, measurement is a major issue. A reliable productivity measurement system should be integrated with the financial one in order to use those metrics to guide and change behaviour (Shimizu et al., 1991, Singapore, 2011).

Figure 3.8 displays the link of the indicators among the three levels cited in the loops diagrams. At the top are wide-ranging metrics giving upper echelons decision-makers information about productivity and profitability.

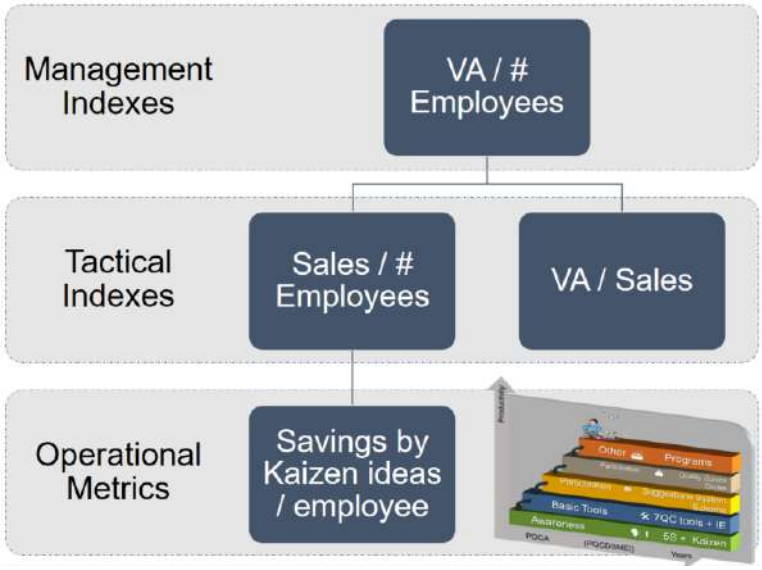

Figure 3.8. Example of indicators relationship among the Loop Levels

The tactical pointers show an overview of costs, activity levels and resource utilisation rates, which are particularly useful for middle and senior managers. The proposed operational indicators will be more qualitative and address further follow-up and monitoring aspects based on the KAIZEN (see previous chapter). Figure 3.9 gives an overview of how each functional area affects overall business performance under this integrated productivity perspective (Spring, 2011). Within Lean, the organizational

objectives are cascaded down into the specific departmental or individual targets demonstrating its multi-factorial dimension within the system and the socio-technical side of the strategy.

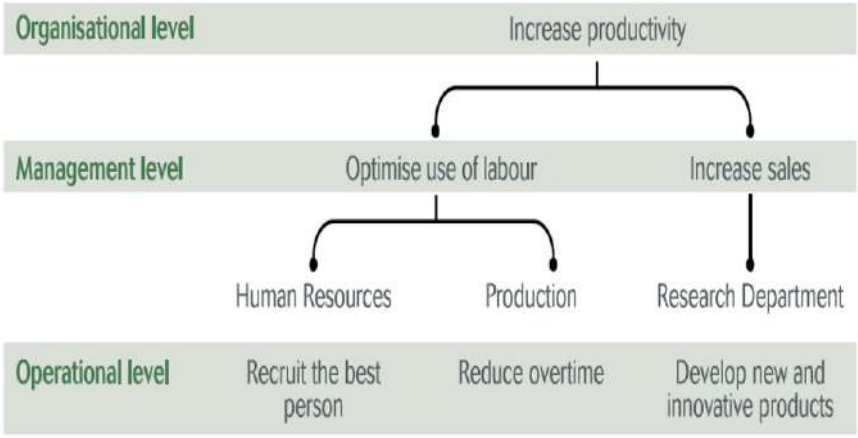

Figure 3.9. Linking indexes among the Levels and functional areas

4.1. Linkage between productivity and profitability

Profitability is greatly affected by efforts to improve productivity; therefore, productivity measurements strengthen strategic planning by providing indicators to ascertain whether strategic objectives have been achieved or not (Shimizu et al., 1991, Spring, 2011). Shimizu et al. (1991) has showed in Figure 3.10 that productivity provides an alternative for unveiling profits. In order to understand the relationship between profitability and productivity, consider the following cases: case I, the ideal situation with high productivity and profitability, means a very solid and financially stable business. Such a situation is sustainable or can be ensured by continuous improvements of productivity.

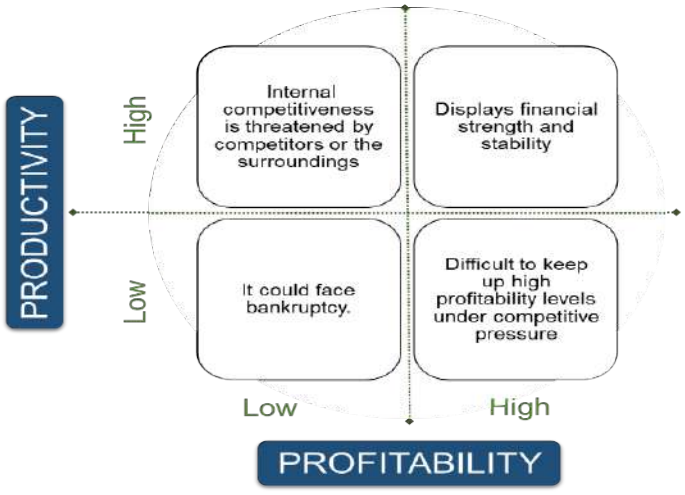

Figure 3.10. Profitability – Productivity Scenarios (Shimizu et al., 1991)

Case 2 denotes high profitability but low productivity. It might be felt that productivity does not need to be enhanced, like in monopoly cases. However, in the long-term,

the low productivity will slowly consume the profits. Thus, the company should start improving its productivity. In case 3, the yield is low despite the high productivity. This situation occurs when external factors affect the operation of the company (e.g., prices are very high or there is an incompatibility between the product and the market). In this scenario, the company will be operating at a loss in a short time; therefore, profitability must be improved through the strengthening of market strategies, conquering new markets, expanding market research, promotions and pricing policy. Finally, case 4 illustrates the less desired situation - low profitability and low productivity. Here, closure and bankruptcy is inevitable.

However, some companies, when faced with this situation, have been able to survive - or rise again - by enhancing productivity and simultaneously developing and reinforcing their market position. Based on this, it is through increased productivity that profits are increased sustainably, by creating value through employee cooperation, increased capital investment and optimal use of capital. Productivity measurements (outputs/inputs), then, are intended to assess how well resources or inputs are used in the making of desired outcomes. So, the first step is to quantify the outputs in three ways: quantity produced (physical quantities), production value (sales value of the finished product units in a given period) and value added (as defined in the previous chapter). Subsequently, the inputs (tangible and intangible - needed to produce goods or services - must be quantified. These inputs are classified as labour (number of employees, personnel costs and total man-hours worked), capital (can be measured in physical terms - machine hours - or by monetary value - fixed assets, machinery and equipment, total assets) and intermediate goods (purchases of materials, energy and physically measurable services - Kg or KW/h - or by monetary value - value of energy purchased, cost of material purchased, etc.).

The employees should be able to clearly comprehend how they are being evaluated and the type of behaviour and performance that the organization recognizes (Shimada and MacDuffie, 1986, Stainer, 1997). This requires the commitment of senior management, teamwork and the participation of all employees. A productivity assessment is only worthwhile when it reflects the organizational goals and objectives and when it is used for action and improvement (Spring, 2011). In this sense, if any productivity intervention is to be effective, deep insight about the current situation is imperative; thus, it becomes important to reach out to productivity levers - areas or activities targeted to enhance productivity (Singapore, 2011). Figure 3.11 diagrams some examples the higher value of products gained by service enhancement or by optimizing quality and production through KAIZEN or even more competencies to the human factor that generates a higher value proposition. Such levers do not work alone; upgrades to one of them involve further actions over others (for example, new technologies will unavoidably demand training of employees and new plant layout).

Shimizu et al. (1991) has cleared up that it is feasible to measure productivity either in terms of physical (units/hour) or by value. Whereby, the first one deals with the basic quantitative unit - although important it is limited whenever evaluating intertemporally, but its results do not guarantee that the changes in trends within a different market can be followed or cannot be used for a comparative analysis. Then, the second one deals with the economic value created through a series of activities. Such a measure entails market fluctuations since it is disclosed by the consumer's recognition of the price paid.

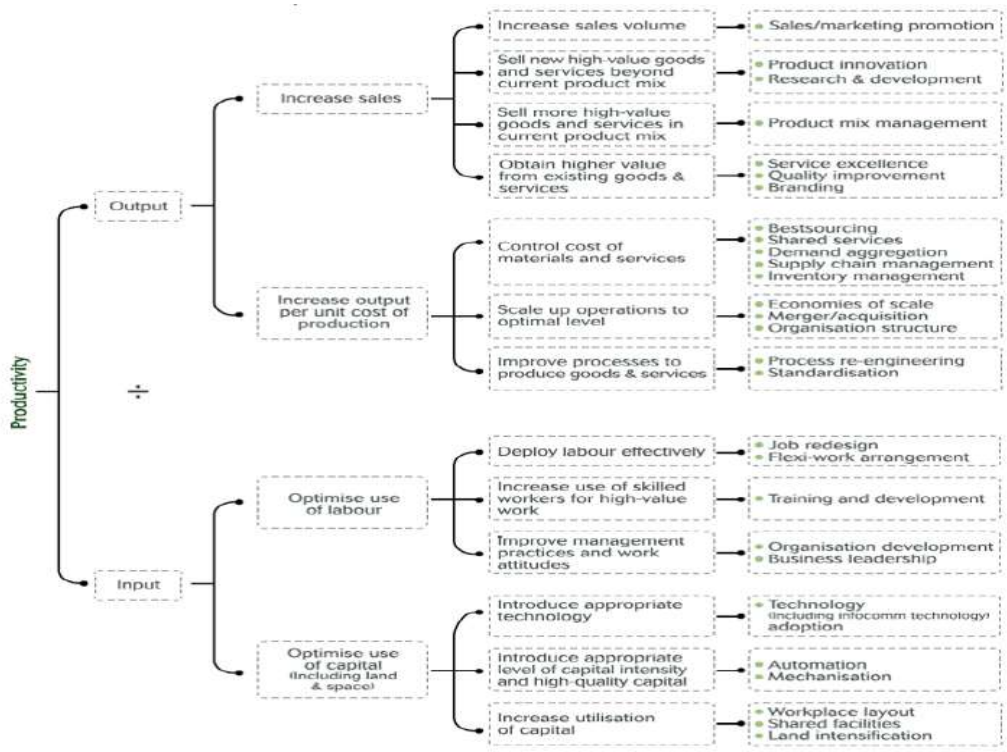

Figure 3.11. Overview of productivity levers (Singapore, 2011)

It is also a way to be compared both with competitors and industry. Therefore, in the industrial and business spheres, the value added tends to be commonly employed for measuring production. Figure 3.12 unfolds how productivity and profitability interact. The left side of the figure is more concerned to the labour side, whose aim is to raise wages. To this end, labour productivity must be boosted, and hence employee skills should be upgraded. Meanwhile, in the right side, managerial pursues improving the total capital index used by improving the Value Added and capital utilization ratios - by further maximizing the materials yield rate. Finally, if the Value Added, capital utilization and capital distribution is enhanced, the outcome will be an overall capital and profit growth. For this reason, management and personnel should be working jointly towards achieving their respective goals (Second Guiding Principle of Productivity).

4.2. Value Added Productivity Measurement (VAPM)

According to Shimizu el al. (1991), the VAPM is a global measure of the whole company, more associated with competitiveness that indicates effectiveness using a market approach. It also focuses on wealth creation as the basis for sustainable operations and analyses the generation and distribution of wealth. Thus, these metrics provide a pattern of action-oriented performance for further improvements, and feedback to capture relevant information for strategical planning and fair distribution of gains –just as the financial perspective in the BSC case. As seen in Figure 3.13, the Value Added (VA) is the best way to measure production performance, since it excludes purchases of materials, energy and services made by suppliers, which are not the result of a

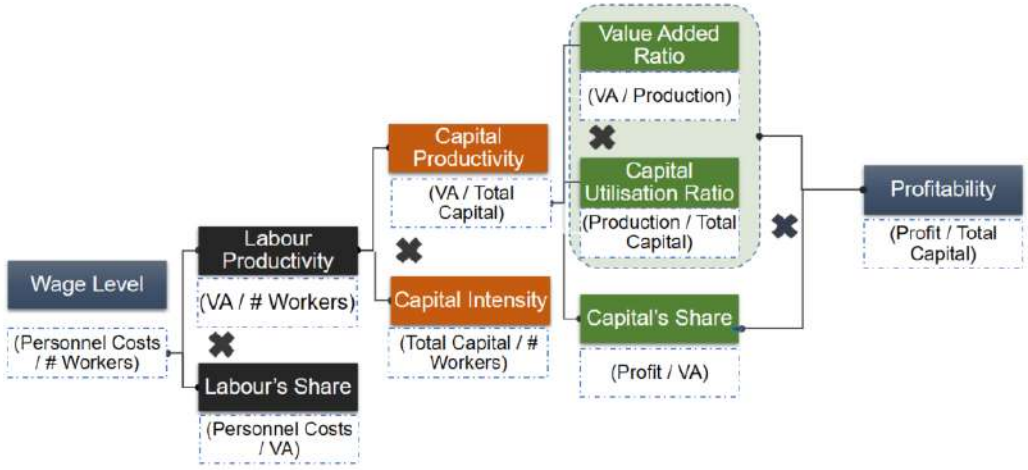

Figure 3.12. Relationship between Production and Profitability (Shimizu et al., 1991)

business's internal operational capacity (Fukuda and Sase, 1994). Strictly speaking, VA constitutes the real production and the source of revenue for an organization from which all the costs of survival, growth and dividends to shareholders are derived. The more productive the organization is; the more VA is created.

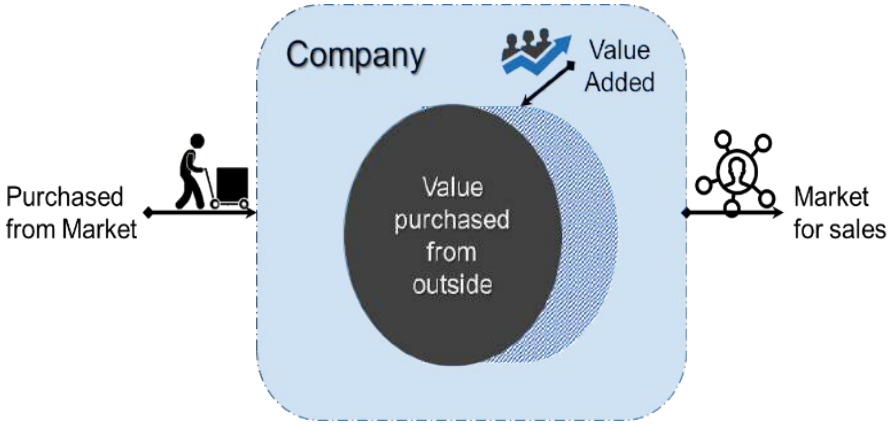

Figure 3.13. Value Added Definition Scheme (Japan Productivity Center, 1988)

Aggregate value is calculated on a monetary basis - terminology used by the managers - drawn from the business' own financial statements. That is why it is critical that the data be reliable and consistent so as to ensure a correct judgement about the true situation of the company (Japan Productivity Center, 1988, Singapore, 2011).

Figure 3.14 summarizes what Shimizu et al. (1991) have explained on differences existing in VA concepts and conventional income statement accounting. VA enables labour payments, depreciation, interest paid, rents, taxes and profits (sum of distributed and retained earnings). In contrast, raw materials and other purchases from third parties are expressed as materials and expenses. In this way, the angle taken here highlights how important depreciation is as a factor in cash flow generation.

Thereafter, the machinery and equipment renewal is not merged in the added value. Yet, for the present work, fixed capital asset capital intensity (depreciation) is one of

its components, particularly given the fact that it is part of monitoring the internal processes perspective within BSC. As well, it can be joined together within levels 2 and 3 of the loops diagrams, specifically at the cost reduction and waste elimination nodes.

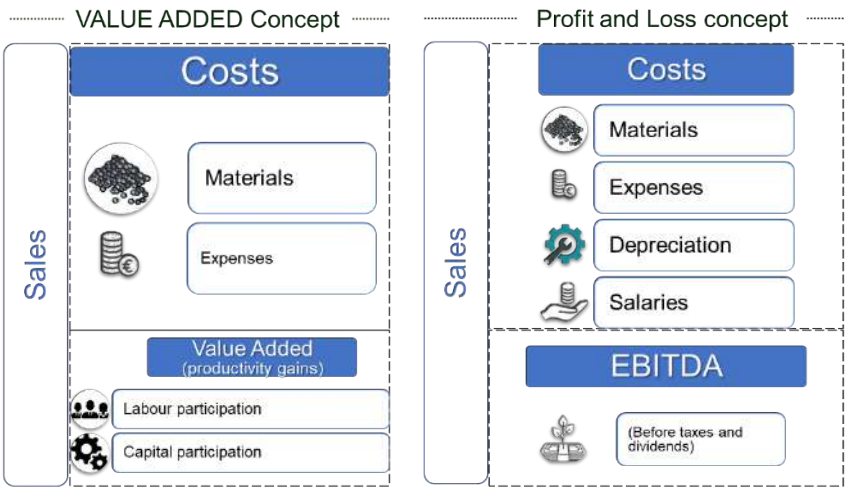

Figure 3.14. Comparison of VA and profit and loss statements (Shimizu et al., 1991)

Lastly, according to the notion of profit and loss, wages and salaries constitute an operating cost - so the lower the cost, the better. Meanwhile, the concept of value added means the net profit from operational work, which must be fairly distributed depending on how contributions were made by those who were involved in the achievement this profit (Third Guiding Principle of Productivity). This leads to cooperation between workers and management (Second Guiding Principle), while the concept of profit and loss usually encourages cost reduction, including wage reduction to maximize profit.

Decision makers should be aware of this scenario as both a tactical and strategic function towards Lean development, and, at the BSC scale, inside the financial perspective. Within the systemic analysis context, it would correspond to level 2 or mid-loop diagram, amongst the set of fair distribution and commitment nodes where both can affect the firm's welfare node. Having this panorama of Value Added in mind, Table 3.1 sets out the main metrics to be adopted (in the next section, they are ordered by BSC format), both in terms of profitability and productivity. In addition, a brief description of what it means and how it works is also suggested. Figure 3.15 highlights how metrics interact in terms of both the creation and distribution of added value.

Indicator	Unit	Formula	Meaning	Description	References
Value added to-sales ratio	%	VA / Sales	Percentage of sales created by the organization when compared to the materials and services purchased.	Efficiency in use of purchases, favourable price differentials between products and purchases, or good control of stocks	(Japan Productivity Centre, 1988)(Shimizu et al., 2001) (Fukuda and Sase, 1994)
Total asset turnover	%	Net Sales / Total Assets	It measures productivity in the use of a company's total resources Total assets are the total investments of a company to carry out its operations and whose objective is to produce and generate sales.	Rotation determines the degree of performance with which current and non-current assets fulfill their mission to generate sales. Only with the quantity of sales made by the company alone is not a sufficient indicator to evaluate the sales results.	(Salas, 2001).
Total Capital productivity	Times	VA / Total Assets	Analyzes how well the assets are used and the capital employed in the production process.	Better use of plant capacity (fewer machine and equipment downtimes, less rework and better material performance, etc.	(Japan Productivity Centre, 1988)(Shimizuet al., 2001) (Fukuda and Sase, 1994)
Return on Assets (ROA)	Monetary	Net Income / Total Assets	It represents the total assets' contribution to the net profit made by the company; in other words, how much the company obtained in net profit over the total investment.	Key to productivity is that management has used its total resources to generate net profits.	(Salas, 2001).
Profit margin	%	Operating profit / Sales	Percentage of sales left after deducting all costs.	Ability to generate high returns from a given amount of sales. On the contrary, costs are too high and are eroding profits	(Salas, 2001)
Worker Participation	%	Personnel Costs / VA	From the total of wealth that the business has generated, what is the equivalent portion to the employees due to their contribution?	Based on Third Guiding Principle of the Productivity Movement	(Japan Productivity Centre, 1988)(Shimizu et al., 2001) (Fukuda and Sase, 1994)
Shareholder Participation	%	Net Profit / VA	Quantifies the total amount of wealth generated from Value Added, which is the corresponding portion for shareholders due to their participation.	Based on Third Guiding Principle of the Productivity Movement	(Japan Productivity Centre, 1988)(Shimizu et al., 2001) (Fukuda and Sase, 1994)
Labour productivity	Monetary	VA / Number employees	Indicates how much VA is created per employee. Raising this ratio by decreasing employees makes no sense nor contributes to the social interest as it causes unemployment.	Increasing VA levels can be done by adding value to the product as it responds to consumer needs, expanding sales, skilled labor, investing physical capital, upgrading technology.	(Japan Productivity Centre, 1988)(Shimizu et al., 2001) (Fukuda and Sase, 1994)
Sales per employee	Monetary	Sales / Number employees	This metric shows how much each worker helps to the sales obtained by a business and thus determines their productive participation towards sales.	Good marketing strategy	(Salas, 2001)
Personnel Expense Contribution to VA	Times	VA / Personnel Costs	It calculates the amount by which the VA results obtained have been productive in terms of the portion transferred to employees (salaries and benefits).	In other words, wage productivity is measured, i.e. how much of the VA is attributable to the cost of personnel.	(Japan Productivity Centre, 1988)(Shimizu et al., 2001) (Fukuda and Sase, 1994)
Total Capital intensity	Monetary	Total Assets / Number employees	Rates the employee participation achievement when producing goods/services for the company	Total assets are the total investment by the business in its operations that justifies its existence; therefore, this index measures the yield of employee engagement in the generation of goods and services.	(Salas, 2001), (Shimizu et al., 2001) (Japan Productivity Centre, 1988)
Sales to Fixed Assets Ratio	%	Sales/ Fixed Assets	By investing in fixed assets, there is a contribution to production and sales operations		(Salas, 2001), (Shimizu et al., 2001)
Fixed-Asset Capital intensity		Fixed Assets / Number employees	Rates the employee participation achievement when producing goods/services for the company	Determines the availability in terms of equipment, machinery and equipment for each employee when performing their duties.	(Salas, 2001), (Japan Productivity Centre, 1988)(Shimizu et al., 2001) (Fukuda and Sase, 1994)
Equipment Productivity	Times	VA / Fixed Assets	Indicates the effective use of machines and equipment in the generation of Added Value	Defined how much of the VA is attributable to the machines and equipment	(Japan Productivity Centre, 1988)(Shimizu et al., 2001) (Fukuda and Sase, 1994)

Table 3.1. A schematic display of VAPM parameters (Spring, 2011)

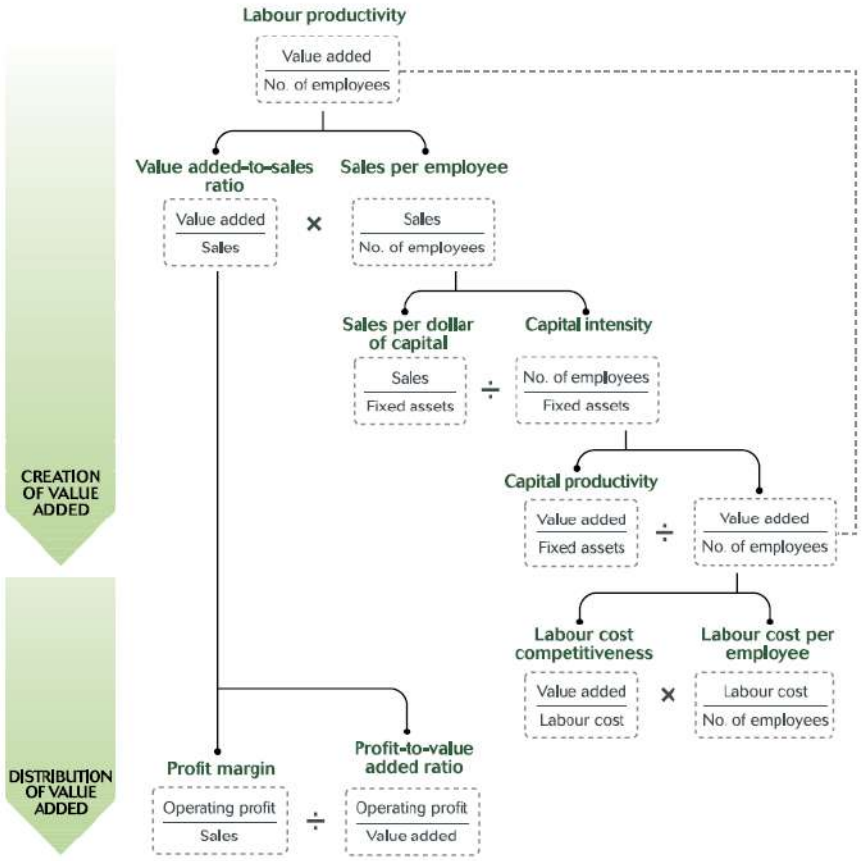

Figure 3.15. A schematic display of VAPM parameters (Spring, 2011)

4.3. Balance Scorecards (BSC) Structure to support the model

A comprehensive snapshot of the mainstream elements within Lean is given in Figure 3.16, whereby its strategy clearly entails fewer resources (e.g. less material or shorter production operations). Simultaneously, a pressure is placed for higher yields (better quality, better technical specifications, more product diversity, etc.). In turn, this should result into the pursuit of value creation towards superior customer satisfaction, and this, as well, gives the business the opportunity to gain a larger market share than its competitors (Katayama and Bennett, 1996).

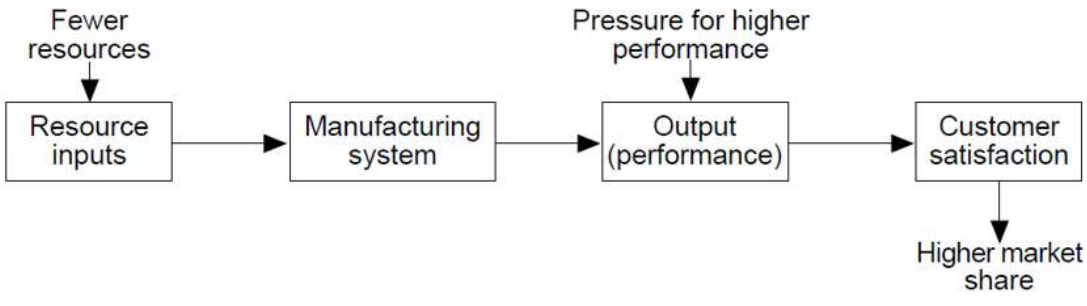

Figure 3.16. Overall picture of the key elements in the Lean (Katayama and Bennett, 1996)

Strategy definition is complicated per se, thus, a roadmap arrangement is required for presenting performance results and why these outcomes are happening. The BSC is a viable way to create a systematic framework behind the Lean system, because it is a management tool that translates the organisational strategy into a cohesive set of metrics (Kaplan and Norton, 2001a,Jones, 2016). APICS, in section 2.1.11, has demarcated "*Balance scorecard theory drives action from strategy by developing specific areas of focus and feedback. Operations controls the flow of inputs and outputs of an organisation and is involved in the scorecard through its impact on financial, customer and internal business processes*" (Castle and Jacobs, 2011). Kaplan and Norton (2008) has proposed in their methodology to begin with strategy development, which mainly involves being aware of the mission, vision and value statements, the competitive positioning and the core competencies of the organisation. In this research, this part integrates both what each enterprise has formulated in accordance with the holistic productivity criteria - comprising the definition, objectives and guiding principles - mentioned in the previous chapter. Then, the framework outlines four specific categories of objectives - or areas of leverage (Kaplan and Norton, 2001b, Poveda-Bautista et al., 2012), see Figure 3.17:

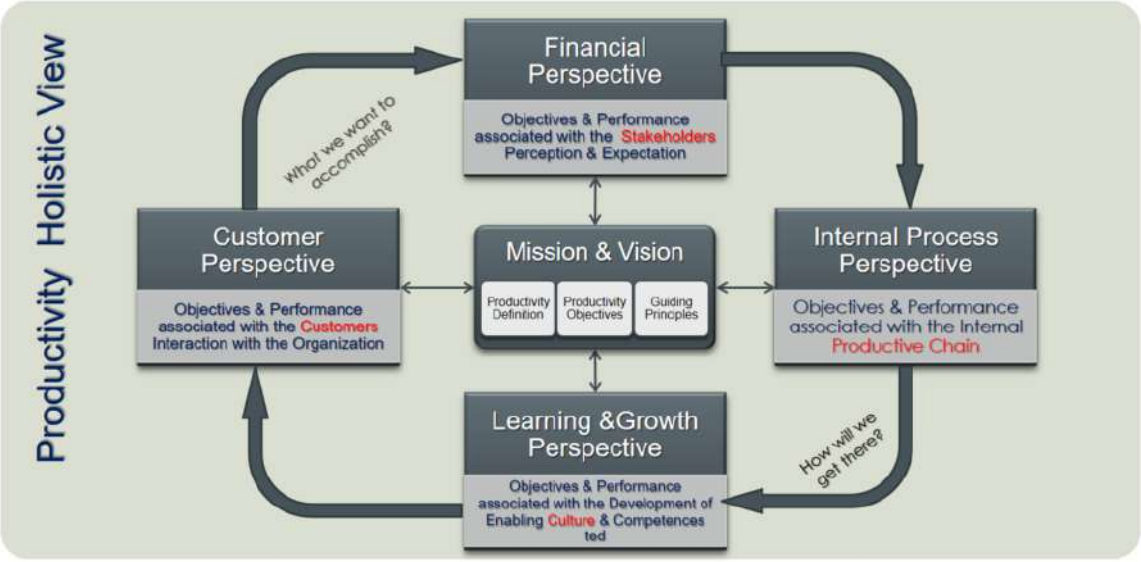

Figure 3.17. Lean Strategy based on Systemic Productivity

- **Financial Perspective**. This category aims to meet the expectations of shareholders, its main focus being to create value for them through performance indicators that reflect the operational performance, growth and sustainability of the company. This factor also represents the final link between the individual objectives of each functional area (element) and the organizational strategy (the whole). In general, this item includes strategic objectives (it would be part of level 1 of the loop scheme) such as increasing revenues, increasing profits, improving operations and using resources and capital. The importance of this perspective depends on giving to shareholders accurate and updated financial performance feedback, as well as whether or not the operation is profitable against the strategic goals set.

  Regarding LP, it is worth recalling the study by Meade et al. (2010) which among its findings (mentioned in the state of the art), conclude on the negative impact

on the financial statements, approximately a one-third decrease in annual net profits, resulting from a rapid reduction in inventories after the initial stages of Lean. In the face of this, executives must be clear about the resistance that could occur if they have a short-term notion; this is especially critical for SMEs.

- **Customer Perspective**. In this segment, what is relevant for the company depends upon its ability to meet its customers' needs and how to satisfy them. In this way, it guarantees loyalty and in the meantime, future customer acquisition for the organization's profitability. Within this range, this provides insight into client perception, which is critical for the revenues to be reflected in the financial perspective. Giving weight to this category is important as a key part of the organizational strategy that will enable the company to successfully achieve its goals and stand out from the competition.

  What is wanted to be Lean is to learn about customers and their requirements. Some metrics are important in measuring customer satisfaction and developing loyal customers (e.g. perception of quality, percentage of complaints, and shortened customer wait times). It takes an internal (and eventually an external) frame for delivering value to its customers. This is why it is imperative to define the value flows within the business (all the actions involved in delivering a given good or service) and also the value streams within broader value chains. But, to satisfy clients, it is necessary to reduce wasteful activities that customers do not want to pay for.

- **Internal Process Perspective**. Typically, the design of performance metrics from this angle seeks to align the activities of employees with operational efficiency. In this way, the internal procedures that make up the value chain can be reviewed and improved in order to eliminate waste. It begins with the innovation process, continues with the operations and ends with the after-sales service that provides added value to customers. Part of Lean's action involves the waste removal along the value chain. Productivity gains lead to more "*Leaner*" operations, in other words, systematic targeting of waste is also a systematic tactical tackle against poor quality and critical management pitfalls (Hines et al., 2004). Each organization demands inputs to turn materials and information into products and services that are attractive to customers. The costs and waste associated with production are necessary in order to justify any improvement efforts.

- **Learning and Growth Perspective**. As can be seen in the previous perspectives (financial, customer focus and internal processes), excellence is sought to achieve the organization's objectives through key processes; however, in the perspective of learning and development, the main point is in human talent, which acts as the means to achieve this level of excellence and achieve the strategic objectives. It must consider human capital (it refers to the know-how of workers as well as their ability to adapt to new challenges in the workplace) and the organizational climate (its measurement indicates how your employees feel working for the company, if they identify with its values and the perceptions they have about the opportunities for change that can help to improve the company as a workplace). It is to this category that the company must pay special attention to obtain long-term results. How managers handle both monitoring and performance appraisal closely illustrates their own beliefs about employee motivation. That is

supported by the research carried out by both Birdi et al. (2008) and Menezes et al. (2010), cited in the state of the art, where they both concluded about the importance of HRM practices (Empowerment, Training and Education and Teamwork) into a Lean strategy.

This classification helps to balance the socio-technical aspects allowing to convert the vision into action and covering aspects necessary for the correct functioning of LP. BSC also balances the external requirements related to shareholders and clients with the internal needs of processes, training, innovation and growth. A company's vision and strategy shape the course of action for individual and global efforts (Porter, 1996). On the other hand, the scheme allows monitoring of the status of how actions are being taken to achieve the vision. From the visualization and analysis of the indexes, it can get feedback on taking preventive or corrective actions to align the overall performance of Lean.

5. Proposed Methodology for Performance Assessment of the Initial Stage of Lean

This section focuses on the general structure of the proposal for implementing the Lean strategy (Hypothesis 2). In order to reliably measure organizational performance and subsequently reach the level of maturity of the system, a solid conceptual basis is required. This is given by adopting a more holistic and comprehensive approach of productivity (Hypothesis 3) that provides the purpose and KAIZEN as its foundation upon which to begin cultural change in a learning organization (Hypothesis 4).

Figure 3.18 sketches out the outline guide of how the proposed methodology for deploying Lean as a complex system should be applied. The key to a well-defined strategy lies in its foundation (Hines et al., 2004). Phase-I provides the essential bedrock for triggering cultural change for a learning organization. This is demarcated by the holistic approach to Productivity and the implementation of KAIZEN (discussed extensively throughout the research) for which appropriate maturation time is required. Ohno mentioned that "*Standing in the circle is taking time to understand reality before acting...Constant practice observing reality became a core value of the new culture*" (Nakane and Hall, 2002). This phase must also be aligned to Lean objectives, which in turn must be in line with the overall business strategy.

Then, the purpose of Phase II is to set up the degree of advancement of the transformation stage through quantitative diagnosis via value added measurement. Likewise, the performance related to productivity levers is determined, which enables to identify where the gaps are between the current situation (refer to Figure 3.11) and the objectives proposed by the organization. It should also be decided what is not being done to reach a new management level - the variation must be understood. Diagnosis should not be limited to measuring and controlling performance; this is not enough. Thus, Phase III points out the improvement aspects, the next step being to complement them with activities that need to be taken to adjust the gaps, as well as

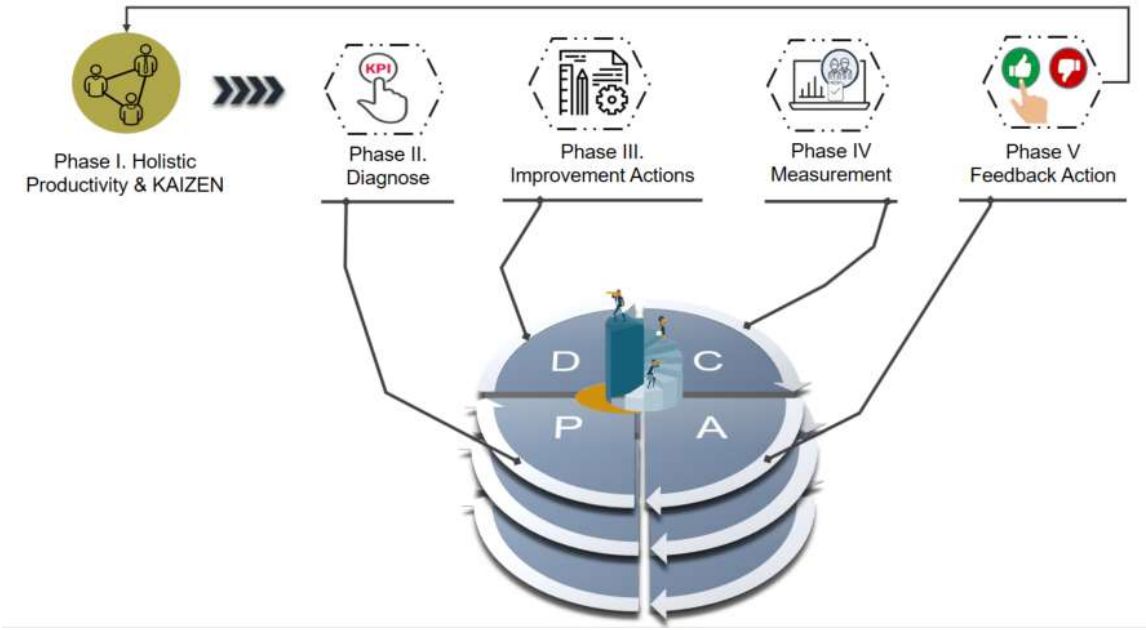

Figure 3.18. PDCA spiral to organize the proposal

assigning responsibility, in such manner that the corrections comply with the strategic plan. Since the organization is seen as a complex system, it is understood that there are interrelations between its elements. Therefore, the implementation of corrective measures will also affect other areas and in turn the whole system. So, Phase IV has the intention of monitoring and controlling the standard of performance and the grade of impact or influence, positive or negative, of the actions taken in relation to the general objective. Finally, following the learning organization approach, embedded into LP, Phase V allows reinforcement of continuous improvement and employee motivation that evidences a sense of pertinence towards Lean. This indicates dynamism and can boost productivity levels. Among the procedures for applying this stage are comparisons of performance in relation to external (value chain or competitors) or internal standards (interdepartmental); benchmarking (by adapting rather than copying) or trend reviews (internal and external). Additionally, it is necessary to encourage incentive schemes for productivity improvement aligned with the individual goals pursued to achieve the overall objectives.

This is in line with what Hines et al. (2004) have said: "*Lean exists at two levels: strategic and operational. In conclusion, we found that the distinction of Lean thinking at the strategic level and Lean production at the operational level is crucial to understanding Lean as a whole in order to apply the right tools and strategies to provide customer value*". In addition, Galichet (2018) has highlighted at least two performance criteria: the first is objective, from an economic (efficiency) and systemic (organizational sustainability) angles, while the second is subjective for both social (human capital) and societal (organizational sustainability) angles. These scopes would define overall performance. Both statements match the author's argument where Lean's strategic view is seen as a multifactorial system which principles, set up and tools complement each other (Hypothesis 6 systems). The Balanced Scorecard is a structure that is able to work

with complexity (Jones, 2016); in the case of Lean, a number of value-added metrics (Hypothesis 5 measurement) allow yield to be assessed and followed up.

5.1. Phase II –BSC structure to diagnose Lean deployment strategy

The mistake of many companies is to turn the scorecard into their own end and concentrate all efforts on getting the data, unaware of the fact that this is only the beginning point for the analysis (Poveda-Bautista et al., 2012). Thus, studies conducted over the past 25 years have shown that a lack of balance between strategy and operational constraints has become prevalent (Kaplan and Norton, 2008). To avoid this, keeping up with the dynamics on productivity, for a proper execution of the plan there are two basic rules: to understand the management cycle (PDCA vision) that links the strategy and the operations, and to know which tools to apply in each stage of the cycle. Figure 3.19 describes how these parameters are associated with the productivity levers with the indicators of VAPM. In this way, by cross-checking these metrics, it is possible to identify bottlenecks along the value chain and work on corrective and preventive efforts.

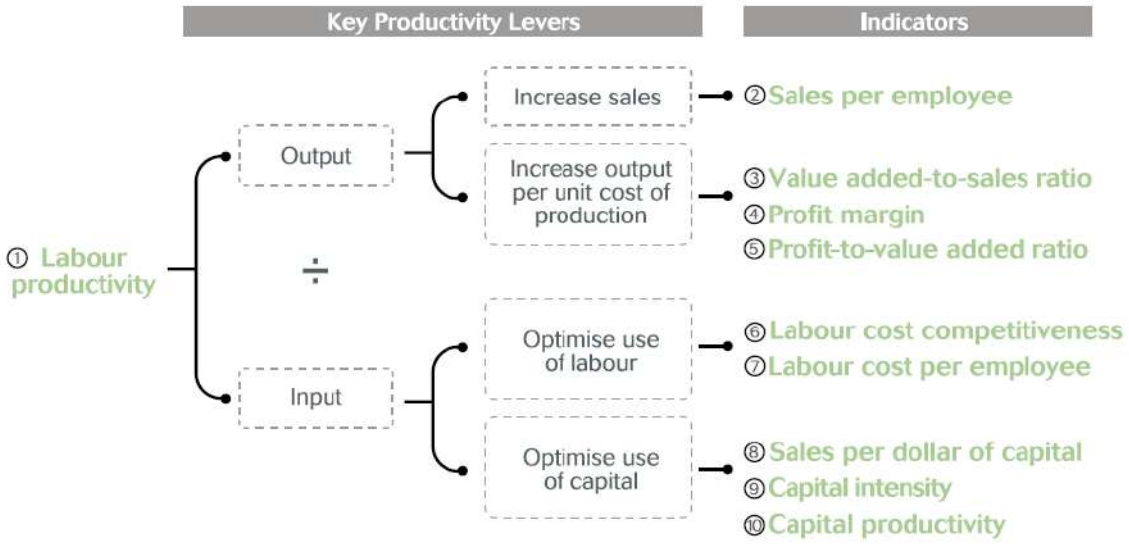

Figure 3.19. Levers of Productivity with regard to the metrics (Singapore, 2011)

We should bear in mind that measurements shape behaviour, because they communicate a message to employees on what top managers believe is important (Lewis, 2000). Therefore, it is important that everyone should address the key levers of productivity: senior management, middle management and functional areas (human resources, marketing or quality control). Initially, this proposed assessment of Lean impact serves as a first-level diagnosis of productivity performance. The following diagram, Figure 3.20, shows that productivity performance depends on the key productivity levers. This makes it possible to determine the effectiveness of the governance function, identify the main productivity levers to be tackled and suggest improvements. The analysis comprises three parts. Part I: Qualitative appraisal of the KAIZEN management function - which initiates proactive cultural change - with respect

to productivity levers. Part II: Quantitative evaluation of productivity performance based on key value-added productivity drivers. Part III: Overall assessment and further recommendations based on the findings of the two parties mentioned before.

So, the BSC format allows a logical evolution of all these indicators, proposed to support decision making in a Lean transformation path. By revealing the elements and their interrelationships, synergy provides the necessary context for the definition of strategies to reduce gaps. Therefore, once the foundations have been laid on which the company's strategy is based (Mission, Vision, Values and the holistic approach to productivity), they are aligned to the Lean strategy.

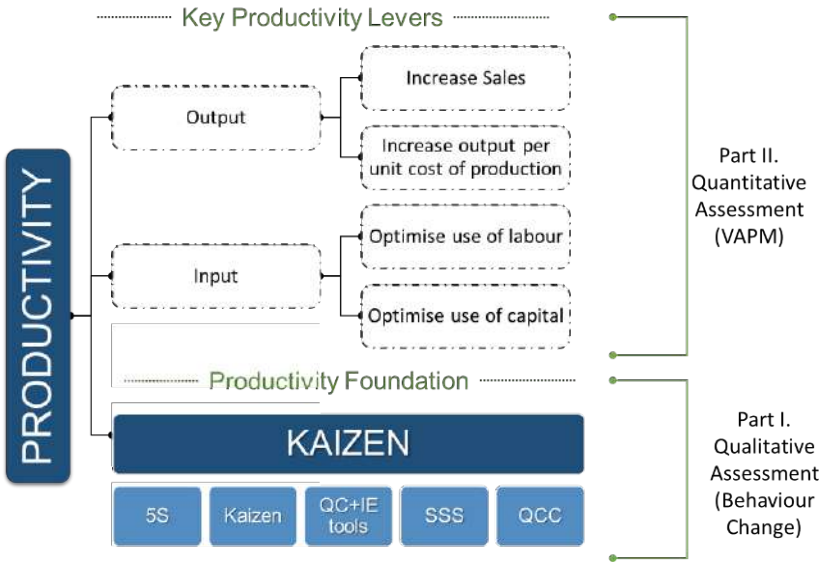

Figure 3.20. Quantitative and Qualitative Productivity Measurement Plan

The following step is to settle down the general objectives - which are congruent with the essence, mentioned above - and categorized according to the BSC procedure, which gives an adequate balance, as can be seen in Figure 3.21. In terms of the Learning and Growth perspective, the goal is for Lean companies to become learning organizations, by strengthening worker competences and building a continuous improvement culture. On that basis, the perspective of Internal Processes will be empowered with productive personnel geared towards finding the most critical problem within the value chain. As for customer focus, in order to be competitive, value must be added to the product before it is priced up, and this is done through cost reduction, quality and delivery time. In the financial aspect, the objectives of growth - productivity and profitability - are considered, but also the balanced distribution of the gains obtained. At the end, all this leads to pursuing the alignment between the need of Lean for performance and organizational purposes.

To go further in the proposal, Figure 3.22 details the categorization of the quantitative and qualitative indicators (explained above) that will measure the progress of Lean. Firstly, Learning and Growth. In this category, the infrastructure required to create long-term value is being identified, since what Lean is looking for is a behavioural change. In this perspective, we consider the results of research by both Birdi et al. (2008) and de Meneses et al. (2010) (discussed in chapter 1) concerning the human

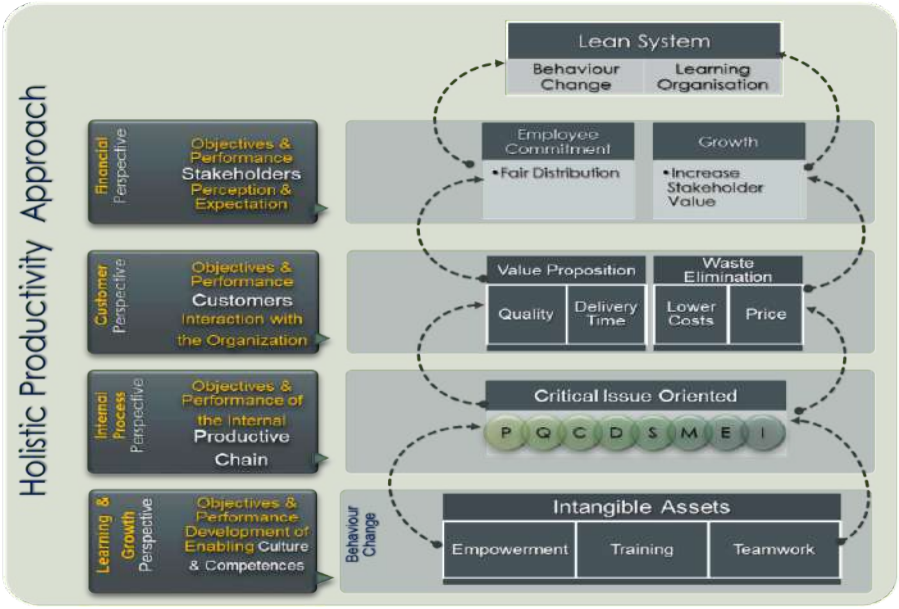

Figure 3.21. Schematic definition of the objectives for the Lean strategy

dimension, centred on three main topics: empowerment, education and training, and teamwork. They are clearly linked to Productivity, whose growth would be 9% of the value added per employee. As for the training, it will be through the OFF-JT methodologies complemented by OJT, and the teamwork through Kaizen projects quantifying them with the savings obtained (the next chapter shows examples). At this early step, the action plan is built on the deployment of the KAIZEN strategy. The 5S audits together with the kaizen projects would provide the main metric for knowing the level of behavioural change. Having said that, with regard to the level of complexity, this part would be related to level three of the loops diagram (explained at the beginning of this chapter).

Secondly, Internal Process, where the key activities and procedures that take place in the business operations influence the productivity - critical issue-oriented, PQCDSMEI - within the value chain. In terms of measurements, the VAPMs - managerial language - used in this perspective are Labour Productivity, Sales per Worker, Total Capital Intensity, Cost Contribution to Personnel, Assets Productivity and Capital Assets Intensity. Nonetheless, more technical metrics - engineering language - can be added to these parameters, for example OEE, Quality, etc., in accordance with the critical aspect of the production process. Hence, the action plan is also based on KAIZEN.

Regarding the level of complexity, this is related to both levels two and three of the loops diagrams, as it mixes socio-technical aspects for the elimination of waste but also strengthens everyone's commitment inside the organization - thus contributing to cultural change.

The third, Client, is a reference to the market in which the company participates. At this point, the client may be external or internal. Now, to satisfy the external customer's requirements, value must be added to the product, offering fair prices and delivering them on time. The internal client -workers-, through the foregoing perspectives, have been meeting their expectations within a learning organisation. The

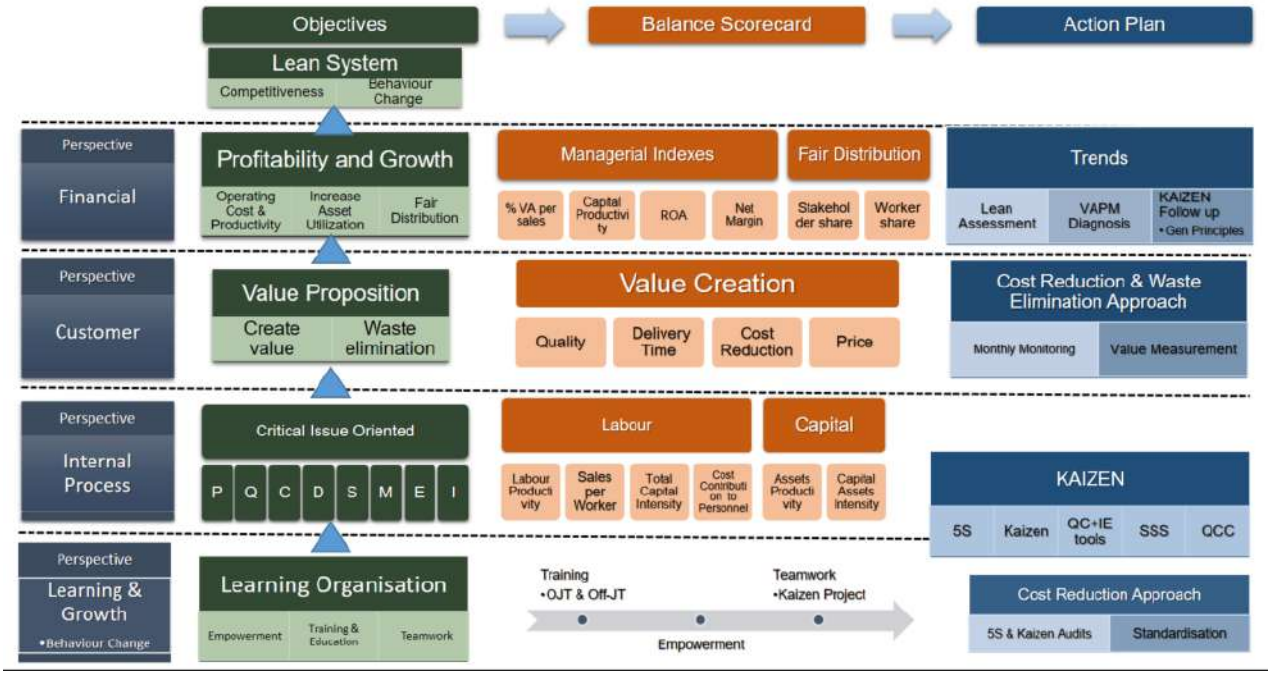

Figure 3.22. Detailed Lean strategy Roadmap

action plan concerning the external customer is to periodically track his preferences and tastes through the marketing team. For the internal customer, it is to continue with the KAIZEN approach and holistic productivity. As far as the level of complexity is concerned, all levels of the loops diagrams would be involved here, as the "*client*" mixes market, competitiveness, socio-technical and other aspects of the value chain.

The latter, Financial, is the most significant for senior management as it reflects the economic and growth situation of the company at any given time. With regard to measurements, the VAPMs adopted from this perspective are as follows: percentage of VA per sales, Capital Productivity, Return on Assets (ROA), Net Margin. Nonetheless, following the holistic productivity view - specifically, the Third Guiding Principle - the measures about the fair distribution of the wealth generated by all those who have contributed are also included, that is, the labour and stakeholder shares, respectively.

For the action plan, the senior leadership should complete the following phases of the cycle (explained in the following sections); underscoring, in particular, the need to apply the "*Gen Principles*" as an integral part of the governance of all Lean activities. Thus, the complexity level under this scenario would be directed towards all levels of the loops diagrams, where everything about business survival and organizational well-being, from market research to behavioural change, is also mixed.

5.2. The other Phases – Continuously manage the Productivity improvement plan

Phase III - Improvement Actions. Just measuring per se has no meaning. It is simply an engine. The idea is to analyse noteworthy findings - i. e. weaknesses, strengths

or trends - for further improvement. After completing the diagnosis (through the BSC indicators), managers can develop an operational plan for the findings or points for further optimisation (PQCDSMEI) based on the results obtained. This roadmap allows to guide specific activities towards a coordinated and systematic approach to Lean operational, tactical and operational objectives. Since the learning organisation (KAIZEN) - the quality control and teamwork circles - has already been formalised, the components of this roadmap address the following:

- What affects productivity? Identify specific actions to be achieved in relation to the diagnostic findings. Detail specific key performance indicators, objectives and results of actions to be taken.
- Who affects productivity? The areas or people who will carry out the actions are identified and responsibilities are assigned to the identified parties.
- When will the activities take place? Milestones and timelines are established for the actions to be carried out. Therefore, these actions must then be made and monitored according to the roadmap.

Phase IV - Measurement. The improvement efforts require further work on monitoring (Gen Principles) as an integral part of the management information system. Moreover, it helps to know whether or not these actions really optimized production processes. Productivity measures can be used to: review the effectiveness of action plans, track progress, set targets and develop new tactics, take into account the various stakeholders (customers, investors, employees, suppliers or funding agencies) and articulate the effort to reward employees.

Phase V - Feedback Actions. Information on productivity performance becomes useless if it does not lead to an introspection of actions for further improvement as part of the PDCA cycle. For this reason, it is important to establish a review and feedback mechanism to gather valuable information for strategic planning and training purposes. The information should be readily available to all employees to improve the performance of the organization or unit in which they work. This phase also enables to check activities in order to reinforce performance and encourage workers. To maintain the momentum of productivity, a direct bond must be formed among rewards and achievements.

The wealth engendered thereby should be distributed to those who have contributed to it. Work incentive systems can influence employee behaviour and align with organizational objectives. All personnel must have a good idea of how and what kind of performance is recognized by business direction. Productivity incentive structures can take different forms: recognition systems - awards can be given to individuals or teams to encourage continuous improvement - VAPM - based on the formula established in phase II –or performance appraisal of staff linked to productivity improvement - good performance should be rewarded with higher bonuses or salaries or other benefits.

Hence, the proposed model must meet the following criteria, as summarized in Figure 3.23:

- Holistic productivity: This principle is fundamental as it will lay the foundation on which the Lean strategy is built, but it must also be compatible with the business objectives. Both will represent the essence of the company (mission, vision and values).

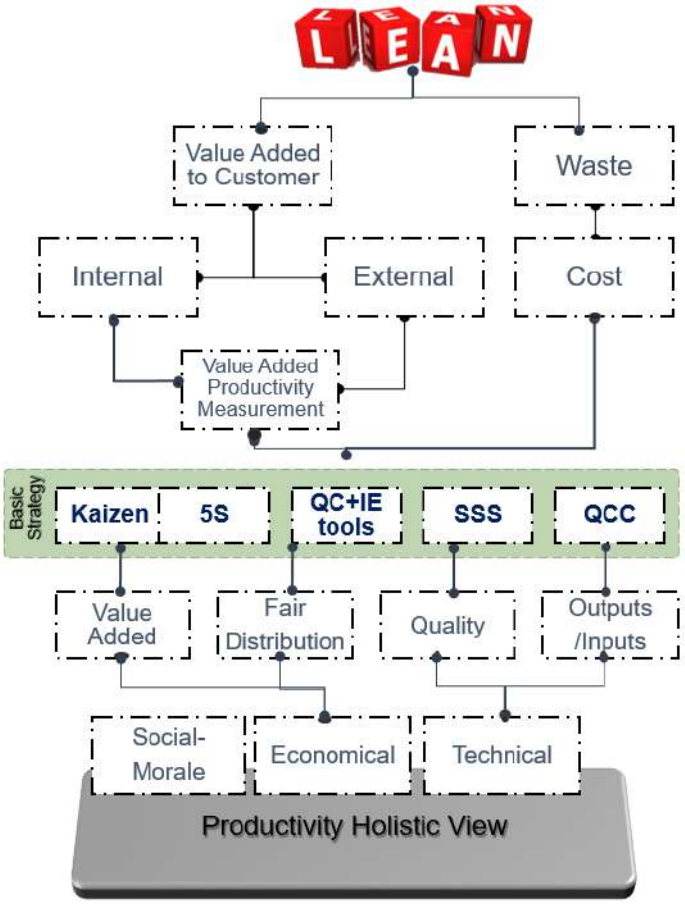

Figure 3.23. Lean strategy and Productivity Holistic view relationship

- KAIZEN: it is the initial strategy for cultural shift, on which holistic productivity is achieved. The basic strategy is to use the minimum set of tools that any firm should set up first regardless of the type of business (large, small or medium). A company should not use one of the techniques if the organization is not sufficiently mature in its use.

- Adaptability: Be generic and capable of supporting various strategic objectives that depend on the organisational strategy and the reality of its own industrial sector. Aims and associated milestones can also be easily changed. Similarly, the process should also enable managers to consider potential new LP enablers and adapt them according to the specificities and complexities of their components.

- Accountability: It spreads to people and areas by identifying clearly and easily what is strategically relevant, which performance levels are involved and who is responsible. The PDCA spiral must be applied always.

6. Conclusions and Perspectives

Within this chapter, underpinning what is implicitly assumed, a methodology has been proposed to respond to the persisting challenges on the application and measurement of the Lean strategy. The principles, organizations, people and tools are complementary to each other; as a result, their combination makes LP a very complex system. An important synergistic factor of the Lean system is Deming's theory of "*Profound Knowledge*", which also allows for the identification of the predominant and holistic role of productivity and quality with respect to JMP, which must be taken into account in any business strategy. In this regard, Ackoff considers that, "*When a system is taken apart it loses its essential properties*" (Gregory, 2007). In other words, the interaction among the parts of the system affects the expected result and therefore the solutions should not be made in isolation (sum of the parts). That is why the use of loop diagrams is one of the mechanisms that we suggest to synthesize the obstacles mentioned in the previous chapter.

To address structural Lean system constraints during its introductory process, two aspects are involved: the deployment - KAIZEN strategy (explained in the previous chapter) and sustainability/follow-up - measurement of the productivity of the added value under a structure given by BSC. Yet, the proposed model does not imply that when implemented within a different value proposition it is doomed to failure. But, in the author's opinion, it can contribute to increasing the chances of a successful transfer within a global system-oriented perspective. This is particularly true for SMEs who require concepts that are easy to assimilate and put into practice. In the following chapter, the proposed methodology will be validated through real case studies at company level.

Chapter 4

Validation of the Methodology for supporting decisions in Lean implementation

Contents

1. Introduction

In accordance with the assumptions set out in the previous chapter, the complexity of the implementation of Lean initiatives has been established, both by the interactions between its network of components (based on a multidisciplinary vision), and by its socio-technical dimensions. Therefore, we suggest that the strategy of formulation and implementation of Lean should be consistent with a global vision, examining both internal and external factors.

To this end, we have attempted to conduct the validation of the proposed methodology based on the two following main choices: (1) review several accomplished projects to analyse application of Lean in the light of the proposed methodology, and (2) measure Lean application through the value-added productivity measurement. It is noteworthy that, for this validation, some empirical case studies were developed on the author's know-how.

The chapter articulates a review of case studies to validate the methodology for applying Lean. In subsection 2.1, it provides six examples gathered from a cement manufacturer which illustrates Phase I of the methodology related to cultural change and the transition behind Kaizen tools. Subsequently, subsection 2.2 continues with a case that discusses how to deploy value-added productivity measurements as a tool to diagnose the current business situation within an SME of the textile sector. Finally, the last part refers to some conclusions and perspectives.

2. Validation Cases for Lean implementation phase

Table 4.1 offers an overview of the case studies for validating the suggested model. As recalled, this approach has a multidisciplinary dimension, by establishing links between different departments within a KAIZEN context as part of a learning organisation. Besides, the evaluation platform is organized around the "*balanced scorecard*" (BSC) format, as it provides a logical sequence for strategic development in any type of company.

Validation through Implemented Projects				
PROJECT		Measurement	Loop Level	BSC Perspective
5S Program	**Holcim**	Behaviour Change	**2, 3**	Financial
Ball Mill MTBF (Kaizen by analysis)	**Holcim**	OEE & MTBF	**2, 3**	Customer
Electric Consumption, (Kaizen by analysis)	**Holcim**	Assets Productivity	**1, 3**	
Ball Mill - Seiso Inspection	**Holcim**	Behaviour Change (PQCDSMEI)	**2, 3**	Internal Process
Dispatch - Seiso Inspection	**Holcim**	Behaviour Change (PQCDSMEI)	**2, 3**	
Safety & 5S	**Holcim**	Behaviour Change (PQCDSMEI)	**2, 3**	Learning & Growth
VAPM Project	**Textile SME**	VAPM	**1,2**	

Table 4.1. Validation of the Proposed Methodology through Case studies

The table also summarizes the interrelationships among these experiences by showing the structural aspects of BSC but also the levels of systemic thinking. For example, the specific case of the 5S program corresponds to systemic levels 2 and 3, is related to the client (internal), and with the "*learning and growth*" perspective since the objective is to initiate the behavioural change inside the Lean organization. The description of some cases on Kaizen and another on value-added productivity measurement will follow, each of the being be explained in more detail in the following sections.

2.1. Validation cases for starting the behaviour change

The following empirical case studies are based on personal experience as a continuous improvement engineer working for Holcim, Costa Rica (mentioned in chapter 1). The general context around the plant is explained in the following:

- The headquarters have established a worldwide policy to ensure their competitive advantage. This requires the adoption of a strategy called "*World Class Maintenance*" (which principles are the same as those proposed by Lean).
- At the same time, they designed a "*pyramid of concepts*" to guide the implementation of this managerial philosophy as well as for acting as a performance indicator for each factory (see Figure 4.1). With this strategy, the Central Offices were looking for a cultural change, better maintenance operations and cost-cutting to enable higher profits at all of their plants worldwide.

Figure 4.1. WCM Pyramid scheme from Headquarters

In Costa Rica, the factory began the deployment by creating task forces at all organizational levels. Each group was responsible for a particular piece of the pyramid; however, the advancement was carried out in a random and disorderly since not everyone maintained the same rhythm, as shown in Figure 4.1. Despite significant breakthroughs, their progress was very slow and the performance required by the headquarters was not met. This caused great concern among the plant authorities, both because of the pressure in Switzerland and also due to the lack of enthusiasm of the workforce towards the initiative, which did not correspond to their expectations. Under these circumstances, the author has submitted a proposal for the support of its strategy, which was accepted by the management. It was held in two parts: the first one consisted to launch the 5S programme within the holistic productivity vision. Once the 5S platform was in place, the second stage would focus on Kaizen, underpinned by JICA's (Japan International Cooperation Agency) expert Kenji Takemura.

2.1.1. Step Deployment –Phase I 5S Program at Cement Plant

Phase I - The implementation of the 5S programme started with a sensitization exercise for the authorities on the real aim of the project, in order to prevent false interpretations. To achieve this, a visit was made to a company where the program had already been launched. This was backed up by training for the managerial level, focusing on the holistic concept of productivity and its relationship with 5S. Then, a committee was built up to handle the whole plant introduction. The entire deployment process took about nine months.

The focus of this research is not on 5S but rather on the underlying behavioural transformation involved. As a reminder, the main objectives of this transformation are to encourage teamwork, to enable practical leadership, to foster Kaizen thinking and to improve the infrastructure. Still, some achievements related to 5S can be highlighted, such as: 100% of personnel was trained, over 500 tons of garbage and other materials were disposed of during a Seiri activity, the visual factory technique was used to promote a safe, clean and better organized environment, but above all, the main efforts concerned the empowerment of the personnel. Figure 4.2 offers an image of a Big Seiso journey, in which the positive evolution of the belt conveyor of the mining operation can be seen.

Figure 4.2. Big Seiso Day at Mining Process

What will be explained in this section is the beginning of the cultural change behind the tool. With these objectives in mind, it is possible to better grasp the true nature of the 5S program, instead of considering it merely as housekeeping. Such an attitudinal shift demands (1) a proper conceptual comprehension, (2) appropriate techniques for a practical application and (3) directions on how to arrange it in a line to support critical-issues.

Point (1) has already been discussed in the previous parts while (2) can be found by reviewing the literature. The focus will be set here on (3) with some examples. The measure of the 5S effects has been done by periodical audits.

Nonetheless, in general these audits are geared towards bearing in mind the housekeeping view, given by the first three S's. From a behavioural angle, the most important thing is to weigh the last two: Seiketsu and Shitsuke. Hence, these two S's should be evaluated by considering the programme objectives as a criterion on which to build behavioural change, then the KAIZEN objectives.

The 5S audit protocol must take into account some important aspects such as guidelines (the checklist), the rating method, in conjunction with the encouragement of healthy in-house competition, and the stimulation of improvement actions, as shown in Figure 4.3. Auditing is a tool that allows achieving the objective of practical leadership, since the "*Gen principles*" can be put into effect here, since directors act as audit members. Auditing is a commitment enabler.

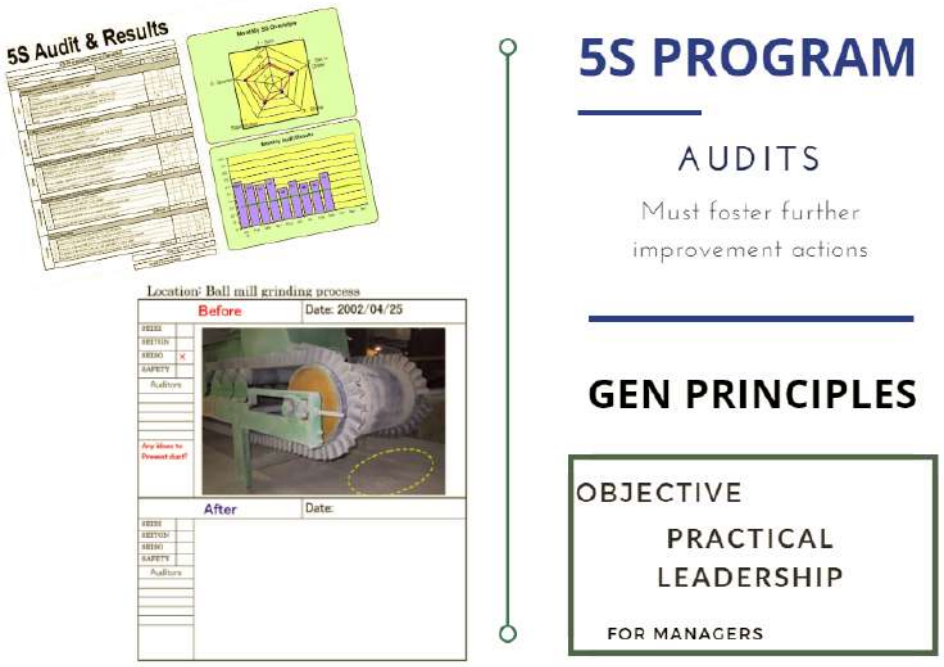

Figure 4.3. Example of 5S Audits made by managers

With regard to the proposal of the present research, the implementation of the 5S programme responds to hypotheses 1, 3 and 4 set out in Chapter 2. It also covers Phase I of the model (see Figure 3.18): KAIZEN based on the holistic vision of productivity. Then, inside the LP analysis as a complex system, the implementation of 5S would belong to levels 2 and 3 (refer to Figures 3.6, 3.7 and 3.20) since it is in fact a foundation for cultural transformation, encompassing the socio-technical and cost-reduction considerations as the expected outcome of this strategy. Besides, under the BSC framework, it will be directly validated within the Learning and Growth and Internal Process dimensions.

2.1.2. Step Deployment – Phase I 5S Program Synergy to Safety

Within the most important global strategical policies of the headquarters is the Prevention of Occupational Risks. This Plant is no exception, so zero tolerance has been promoted towards accidental situations or whatever may cause them, in order to avoid or minimize the risk as much as possible. Upon adoption of 5S and on the successful experience gained at the time, management has requested the 5S committee to support safety and health efforts. This is coherent with what was stated by the program for the sustainability phase, i.e. synergy with the critical-issue oriented - PQCDSMEI - (as explained earlier). This is why it would be wrong to integrate a sixth S as part of the 5S, as many companies have been doing according to the literature review.

In this context, the second phase began: sustainability, with a combination with Kaizen. Therefore, the committee began to analyse the current situation at that time, as summarized in Table 4.2. Some facts were exhibited here: (1) there were no management meetings on safety. Although the reports were made by the area supervisor, no discussion was held with upper and middle echelons, except when something serious had happened, (2) there was poor promotion and communication about the importance of safety in the workplace, considering what was the policy of the headquarters; (3) some documents were available about it, but not adapted to the cement plant.

Facts found by analysis	What do you do as countermeasures?	How do you implement countermeasures?
25% accidents occur to workers under 5 years experience 75% accidents occur to people over 5 years experience	To reduce a maximum of accidents	5S/Kaizen sinergy, Kiken Yoshi (risk prediction) Training and use of Standards
40% accidents occur at peak demand (10-12 am)	Decrease to a maximum of 5 accidents during peak demand (10-12 am)	To raise awareness among operators/technicians during planning for peak demand jobs and gemba walk
70% of all accidents involve mechanics, 25% operators and 5% electrical personnel	To reduce a maximum of accidents	To undertake a survey in detail on the people (alcoholism, drug addiction or problems)
76 days without accidents	To reach 300 days without accumulated accidents	To develop information boards and other safety measures
50% of accidents occur on Mondays and Saturdays	Cut to 15% of accidents on Mondays and 8% Saturdays	5S/Kaizen sinergy, Kiken Yoshi (risk prediction) Training and use of Standards
From 20 accidents in the year, 8 occurred by knockdowns (40%)	To reduce a maximum of accidents	To include accident statistics
No meetings with top and middle managers or statistical reports	Monthly meetings and awareness meetings between managers and the personnel	To provide statistics into internal reports, 5S Audits participation and peridiocal Gemba walks
Poor safety communication		Promotional activities aimed at goals, training, activities and intermediate milestones.

Table 4.2. Safety Findings at the cement plant

At this point, the 5S committee began the work by collecting information and keeping statistics as well as monthly meetings with the authorities, organising trainings

at all levels, conducting investigations on accidents and incident and including safety-at-work elements into the 5S audits. An awareness-raising exercise called "*Accident Free Days*" was launched. To this end, a board was built indicating the number of days reached without injuries; the table was uploaded when nothing happened, as can be seen in Figure 4.4. However, if an accident occurred, a "*descent ceremony*" was held, where the managers and the area supervisor lowered the sign in front of all personnel. During this meeting, an official update was given to the community on what had happened and awareness was promoted. Whilst, with all these actions a maximum of 150 days without accident was reached. This was a good achievement because, previously, awareness at all levels of occupational safety was based on a few concrete actions by the person in charge and minimal involvement by top managers. Prior to the 5S deployment, the maximum number of accident-free days was 70 with a frequency rate of 38.

Figure 4.4. Improvement actions, initial steps towards occupational safety

This Safety at Work project, supported by Kaizen using the analysis technique, responds to the hypotheses 1, 3 and 4 explained in Chapter 2. This example deals with Phase I of the model (according to Figure 3.18): it is an example of the Critical Issue Orientation. In this way, within the LP analysis as a complex system, it would correspond to levels 2 and 3 (refer to Figures 3.6, 3.7 and 3.20). Indeed, it is in fact a basis for cultural transformation, covering socio-technical and cost reduction requirements. Under the BSC umbrella, it will also be validated under the Learning-Growth and Internal Process Scope.

2.1.3. Step Deployment – Phase I 5S Program Synergy to Maintenance

Further to the actions subsequent to the 5S platform establishment, an activity was held in two different areas, Milling and Dispatch. This activity was a Seiso-Inspection and was scheduled to be performed at the Ball Mill 3 and on the cement bag palletizing equipment. It was one of the actions taken for the cases detailed in next sections (2.4 and 2.5).

We must bear in mind that any 5S or Kaizen project must pursue its objectives (refer to chapter 2, section 6). Thus, this activity fosters them whilst enabling the efforts towards a critical issue-oriented perspective. In this sense, a preventive attitude is provided within a business learning organization, whereby for this case, it is geared towards its role within the TPM philosophy, particularly integrated with autonomous maintenance. The fact is that even when operators have a very basic understanding of how a machine works, they may notice the early signs of large potential problems and give valuable hints to the maintenance staff.

Within Seiso-inspection, the emphasis is to identify abnormalities in operating conditions, as shown in Figure 4.5, for further corrective actions as well as documented. The used methodology involves OJT (On the Job Training) training and seeks to verify the functioning through in-depth contact (uncovering).

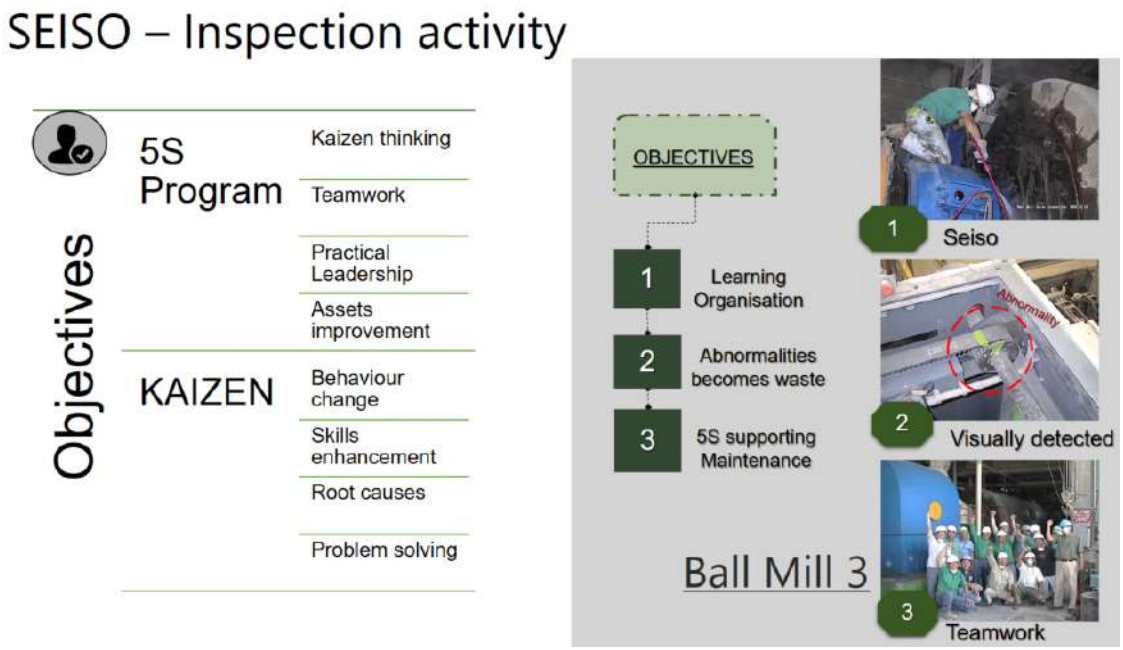

Figure 4.5. 5S program activity-supporting Maintenance

This is why it is necessary to distinguish and divide the equipment according to its functions: Electronics/Instrumentation, Hydraulics, Mechanics, Electrical, Lubrication and Prediction, so that the maintenance group can establish corrective and preventive countermeasures.

The Seiso-Inspection activity from the 5S programme responds also to hypotheses 1, 3 and 4 of the proposal (see Chapter 2). It also covers Phase I of the model (see Figure 3.18) since it includes the aspects mentioned by Deming about the theory of Profound Knowledge (appreciation for the system, variation and psychology). Then, inside the Lean as a system analysis, it would belong also to levels 2 and 3 (refer to Figures 3.6, 3.7 and 3.20) since it promotes constant raising of awareness by covering socio-technical and cost-reduction considerations. As a final point, under the BSC setting, it will be validated within the Learning and Growth and Internal Process dimensions too.

2.1.4. Step Deployment – Phase I Kaizen by analysis - Ball Mill Performance

In this milling process, the clinker is crushed and blended with materials such as gypsum or pozzolan, resulting in cement. To do this, ball mills are used (see Figure 4.6), which consist of a cylinder that rotates around itself and contains steel balls inside. Thanks to the centrifugal cycle, the balls collide with each other, crushing the clinker together with the additives to obtain a fine, homogeneous powder: the cement.

Figure 4.6. Cement Ball Mill Status at that time

The manager of the area was worried about the process yield, which was not as expected, plus the high manufacturing costs. On the basis of the KAIZEN platform that has already been created, a mixed quality control circle (a combination of engineers, maintenance personnel and operators) was set up to develop a "*Kaizen by analysis*" project. Evidence of the circumstances at that time indicates that the current MTBF (Mean Time Between Failures) at mill 3 was 25 hours, meaning that the machine stopped at least once a day approximately (see table 4.3). For this reason, the team set a goal to improve the MTBF of mill 3 up to 50 hours.

In total, there were 132 stops in 5 months. Following the analytical process, by working with the quality tools, it was determined that 86 stops were less than one hour, 37 stops were between one and five hours, 9 stops were more than five hours. Afterwards, a Pareto diagram revealed that the main problem was due to feeding stoppages, with 34 stops in four months. The first task that was done was then to implement the Seiso Inspection. Subsequently, some other countermeasures taken were checking and upgrading preventive maintenance routines, improving mill control through the Kaizen project, raising awareness among maintenance and process personnel, improving material storage capacity in hoppers, improving oil cooling system and mill ventilation, optimizing raw material storage and transportation, modifying high-efficiency separator system.

Facts found by analysis	What do you do as countermeasures?	How do you implement countermeasures?
Current MTBF of the mill 3 = 25h	To raise the MTBF of the mill 3 = 50 h.	• Review and upgrade of preventive maintenance routines • Improvement of mill monitoring through the integrated system • Awareness of Maintenance and process personnel • Enhancement of material storage capacity at the hopper • Improved oil cooling system and mill ventilation • Optimization of storage and transport of raw materials • Modification of high-efficiency separator system • Use of procedures
Downtime trend 65% 1 h, (86 stoppages) 28% between 1 and 5 hours (37 stoppages), 7% 5 hours (9 stoppages), total 132 stoppages in 5 months	To shorten to 20 stops 1h, 10 stops from 1 to 5 hours, 2 stops 5 hrs in 5 months	To link 5S with the maintenance (SEISO inspection) of any area or equipment.
70% of all accidents involve mechanics, 25% operators and 5% electrical personnel	To reduce a maximum of accidents	To improve the alarm system (jidoka)
Total downtime per hopper = 34 times in 4 months	To minimise stoppages per bin to twice a month	• To avoid the entrance of oversized pieces into the hopper • To move the balance control system onto the integrated system
Same cause of shutdowns repeated (maintenance or process) in the same day	To decrease to zero downtime for maintenance the same type during the same day	• Awareness raising among maintenance personnel • Use of procedures • Gemba walk by the supervisors • Routines improvement for preventive and predictive maintenance. protocols. • Better maintenance inspections while equipment is in operation
Maximum number of continuous days without stoppages is 7 days	To reach 14 continuous days without shutdowns, covering from June to October.	

Table 4.3. Ball Mill 3 current data at that time

Figure 4.7 illustrates some of the discoveries and corrective actions taken. Throughout the process, trash and other kinds of waste were found, such as old chain pieces from previous repairs that obstructed the passage of the clinker to the mill or accumulation of material on the hopper walls causing avalanches that forced the entire process to

stop. As solutions, grills were placed at different points of the production process; compressed air cannons were also installed inside the hopper to prevent material from accumulating. Lastly, towards the end of the hopper, when the material was unloaded onto the conveyor belt prior to entering the mill, a kind of opening door was fitted that opened when the material exceeded the entry capacity, allowing the operator time to clean, thus preventing the equipment from stopping. The next step was to verify if the actions undertaken really helped to raise the efficiency of Ball Mill 3. Figure shows an historical growth in MTBF (see blue line on the graph). At week 21, the team began the project. In week 36, the goal was reached, but then it dropped. Despite this, it was finally possible to surpass the target and achieve 80 hours of undisrupted mill stoppages in week 44.

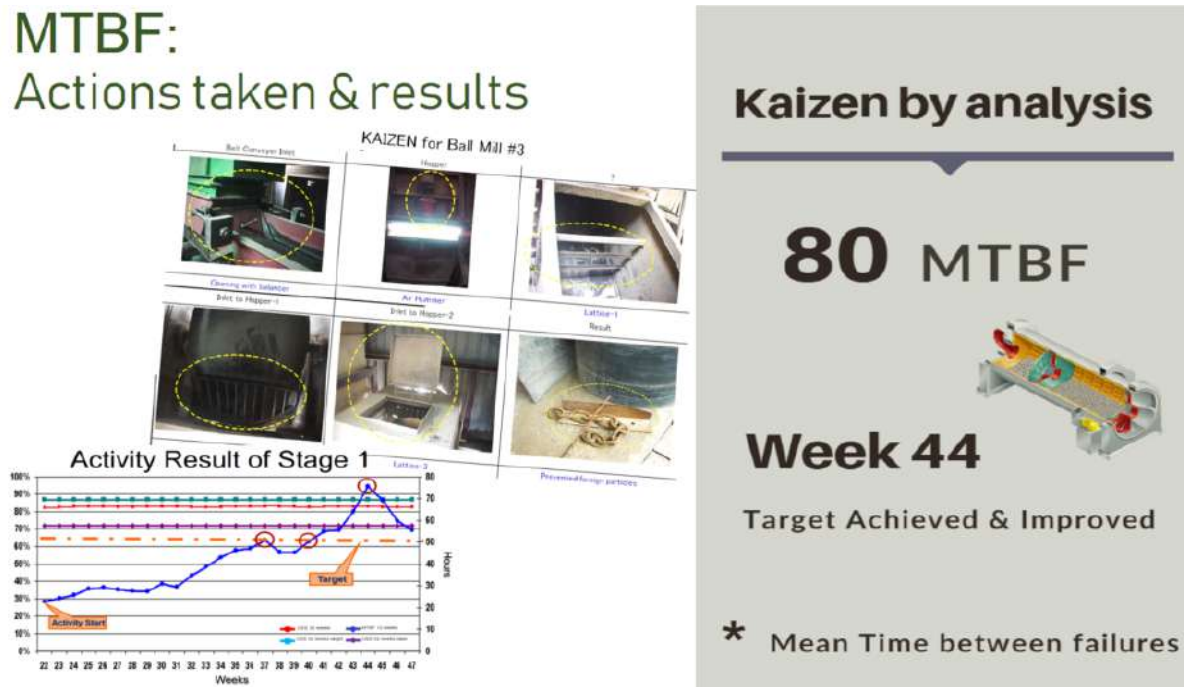

Figure 4.7. Findings and countermeasures taken in mill area 3

As for the proposal, this example corresponds to hypothesis 1, 3 and 4 given in Chapter 2. It is a part of Phase I of the model (Figure 3.18): 5S and Kaizen by analysis gathered to support the Critical Issue of Maintenance. Subsequently, seeing the Lean strategy as a complex system, it would be captured in levels 2 and 3 (shown in Figures 3.6, 3.7 and 3.20) since it involves a work team of supervisors, engineers and operators who solve a common problem, encompassing socio-technical and cost cutting constraints as the result. Meanwhile, under the BSC's umbrella, the perspectives of Learning and Growth and Internal Process are mixed.

2.1.5. Step Deployment – Phase I Kaizen by analysis - Dispatch Process

The next Kaizen project for analysis was held in the Packaging of the cement area, at bulk and Expedition (CEPAL). Here, the cement is bagged or loaded into a truck for

transport to the customer. In this area, the manager also wanted to improve the performance indicators due to the clients' complaints about the constant receipt of broken bags (see Figure 4.8). A team was formed and after visiting the gemba, a high pollution level was observed because of the cement dust.

Figure 4.8. Packaging situation at that time

Table 4.4 quantifies what was found at the workplace: there was a 10.40% drop in production within the period under review caused by constant equipment stoppages, but particularly 198 stoppages were due to empty or broken bags, thus yielding an OEE of 47% while the expected one was 75%. At the group meetings, the possible causes of the malfunction were pinpointed employing a fishbone diagram, as shown in Figure 4.9. As a result of this analysis, it was decided that the priority was on the palletising machine and more specifically on the conveyor belt. A target of an increase of 70% in the OEE was chosen.

The first thing to do was to perform a Big Seiso Inspection, i.e. a 5S effort towards the equipment maintenance (mentioned in section 2.3 of this chapter). The critical points of contamination were determined.

Following this analysis, the taskforce drew up a kaizen by idea to initiate the actions for pollution mitigation underneath the conveyor belt of the machine. As a pilot experiment, this idea included a basket, a tube and a collecting box, first made of carton and adhesive tape. Then, if things worked out well, the second step would be its construction with sheet metal, pictured in Figure 4.10.

Subsequently, with regard to the broken bags, several corrective steps were adopted in response to the problems, listed below:

- Deformation and inspection of wooden platforms. Action: optimize the shape of the platforms to avoid deformation. Weekly checking of the condition of the pallets and removal of the problematic ones. Place no more than 10 to 12 pallets on the dispenser.

Facts found by analysis	What do you do as countermeasures?
OEE for 13 weeks is 47% whereas the plan is 72%	Target set to improve OEE for successive 3 months to 70%
Production Rate for 13 weeks (at 24th week) is 73%	Target set of production rate to improve to 75%
Bag break happened 158 times among 441000 units (0.04%) in a month	Priority for the Kaizen activity to improve: I: Pallet pack II: Conveyor III: Automatic packing machine - Seiso Inspection
Machine stopped 198 times due to empty bag.	
Reduction of production rate due to empty bag was 460 minutes. It caused of production 10.4%	To decrease to zero downtime for maintenance the same type during the same day

Table 4.4. CEPAL actual situation at that time

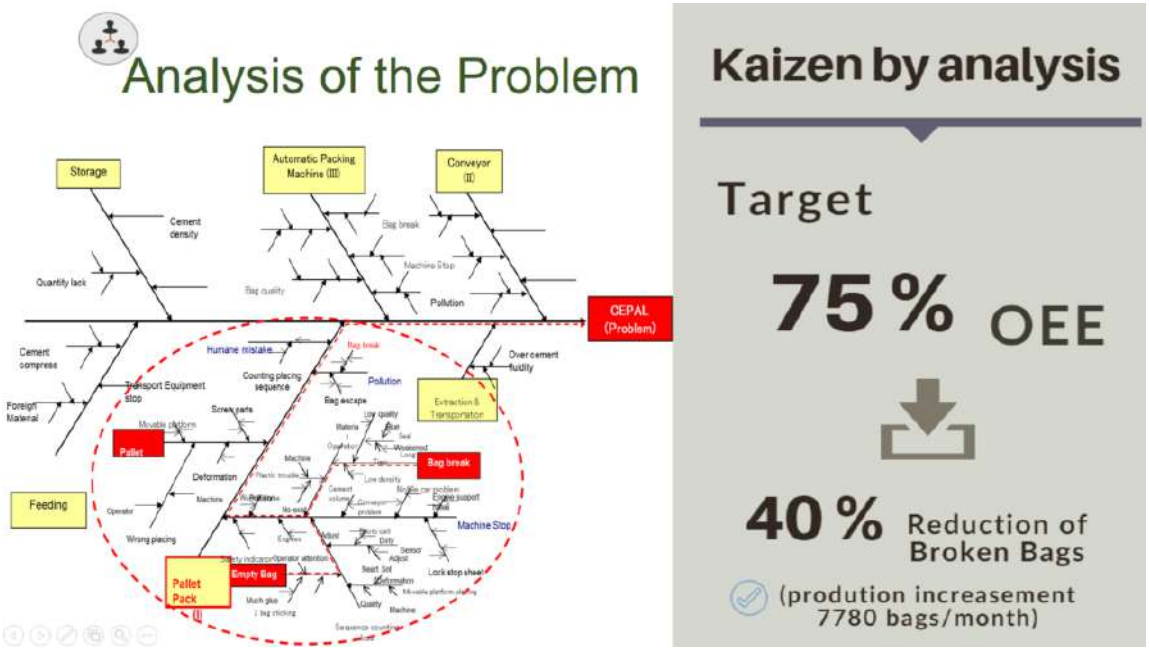

Figure 4.9. Cause and Effect Diagram of the problem - CEPAL

- Glued bag. Action: coordinate with the supplier for the removal of the glued bag and a proper drying process (3 weeks). Adjust the Palletizer to suit specific requirements.
- Bag quality. Action: improve communication with the supplier. Perform monthly meeting and quantify breakage at CEPAL due to bag quality causes.

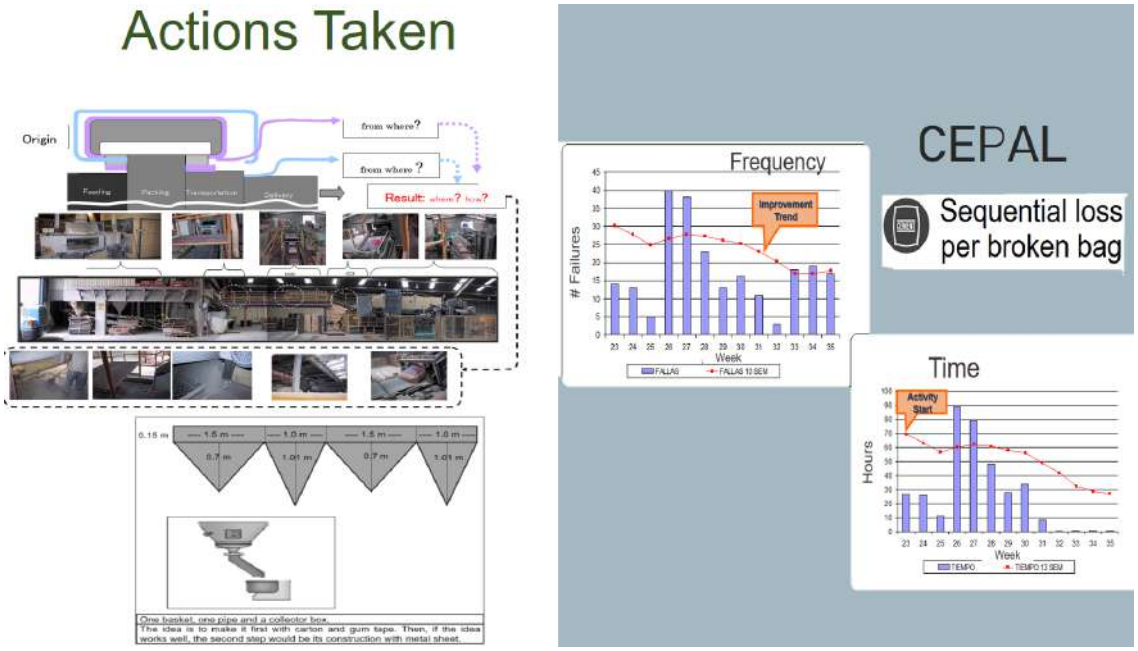

Figure 4.10. Actions taken and results at CEPAL

This scenario corresponds to the deployment step, which belongs to both the 5S programme and Kaizen by analysis. Both tackle hypothesis 1, 3 and 4, exposed in Chapter 2. Besides, it fits into Phase I of the model (see Figure 3.18): KAIZEN involvement, but at the same time, triggers what is an intermediate element of sustainability.

On the other hand, by analysing this case in the context of "*Lean as a system of systems*", it would be included in levels 1 and 3 mainly (as shown in Figures 3.5 and 3.7) since it confirms the behavioural shift, embracing factors such as customer satisfaction, better working environment and cost-cutting, as expected by the Lean strategy. Finally, with regard to the BSC context, the perspectives that directly influence it are Learning and Growth, Internal Process and Customer.

2.1.6. Step Deployment – Phase I Kaizen by analysis - Electric Consumption

This project was carried out in the Clinker production process - an artificial material obtained from the calcination of prepared clay limestone mixtures with the addition of other materials. This is the main part of cement production. At that time, the management of the Clinker was concerned about very high cost due to electricity

consumption, so it was decided to execute a Kaizen by analysis project based on a quality control circle at the engineering level towards this type of waste. In the clinker process, there were 13 motors consuming electricity and the total consumption was 4168 kW (Figure 4.11). The fan 421-VE1 (main bag filter fan) consumes about 1082 kW, which gives a specific consumption of about 18.9 kWh/ton clinker.

The electric load of the fans is affected mainly by the high quantity of cold air it has to transport during direct operation in order to protect the filter bags from burning. The outlet temperatures from the pre-calciner and preheater go up to 350°C and the filter has to be protected from temperatures higher than 180°C . The team thought these factors could be reduced by increasing the set point during direct operation, because the current filter bags, made of Teflon, are able to resist up to 260°C continuously, according to the supplier and to the last tests done by them. The temperature-setting was changed from 180°C to 260°C for testing.

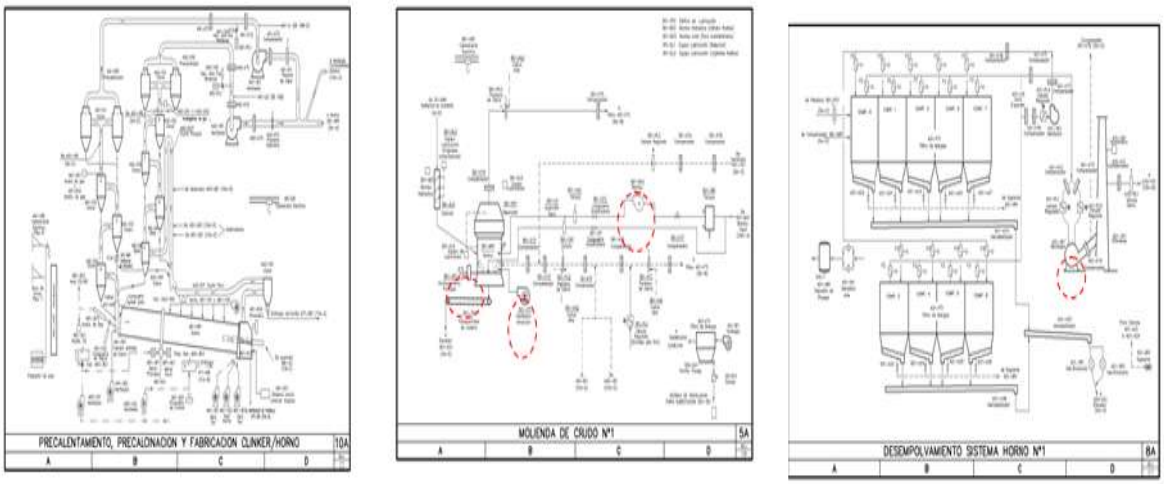

Figure 4.11. Clinker Process Flow Diagrams

Hence, the higher temperature setting reduces cold air supply to the system by automatic control. Thus, it reduces the volume of the air the fan has to transport. The Figure 4.12 shows the reduction in energy consumption from 1082 kW to 543 kW and in units consumed from 18.9 to 9.6 kWh/ton (9.3 kWh/ton). From this, the Kaizen project was able to save nearly $25000/year in electricity consumption at the Clinker area.

This last instance, associated with the deployment step of Phase I (see Figure 3.18), has emerged as a Kaizen by analysis towards hypotheses 1, 3 and 4 of Chapter 2. Nonetheless, this is a very technical Kaizen because of its degree of difficulty, given the engineering nature of the problem. If Lean were seen as a complex system, this project would be considered in levels 2 and 3 (Figures 3.6 and 3.7) because it supports attitudinal transformation towards solving operational pitfalls, impacting waste levels and thus decreasing production costs.

Finally, with regard to the BSC structure, the perspectives that its application would bring are Learning and Growth Internal Process and Finance.

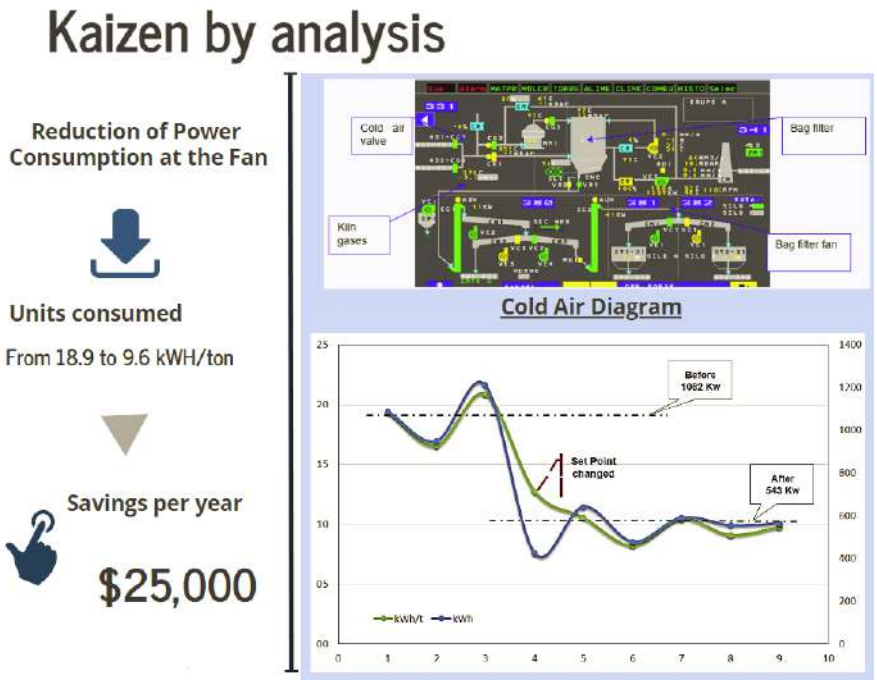

Figure 4.12. Cold Air Diagram during burning operation

2.2. Validation Case for Lean assessment

The objective of the project was to assist an SME from the textile industry to evaluate its productivity towards improving its process and financial skills. VAPM tracks the performance of a company and determines how effective its actions are, as well as if its plans are on track. The company was willing to show its financial statements (for the purposes of this example, the information was altered to avoid giving real data, yet its trend remains), which allowed us to demonstrate the applicability of this assessment. The historical financial accounting information (Income Statement and Balance Sheet) provided was for three years (2008 to 2010) and it was used for calculating the Added Value while generating further indices. With this, the diagnosis was performed, allowing to determine constraints (phase II in the model map), then to recommend improvements (phase III). It is worth mentioning that according to the suggested proposal, the first step is the establishment of the KAIZEN strategy, however, for this company this stage was not fulfilled. This was because the objective of the study was to establish an empirical case on the application of VAPM as a diagnostic tool for Costa Rican SMEs. Thereafter, no further budget was available to continue technical support for the project.

2.2.1. Step Sustainability – Phase II VAPM Diagnosis at the SME

According to the information contained in the financial statements, the calculation of the indicators is presented in Table 4.5

Section I of this table indicates the financial point of view of the company. These results reveal that initially, the percentage of VA in relation to Sales for 2008 the company

generated 60% of wealth over total sales, with an increasing trend for the next period (Figure 4.13). For 2010, a slight decrease is present due to a rise in personnel expenses and taxes and fees. This could be interpreted as a good management performance in terms of improving net sales and value added, but labour costs have to be improved. With respect to Capital Productivity, in 2008, the productivity in the effective use of assets in the generation of Added Value was 99%, with an incremental tendency over the time periods being studied. This means a right use of capital due to a better use of installed capacity and less downtime of machinery and equipment, less reprocessing or better performance of materials, etc.

Formula		Metric	2008	2009	2010
VA/Sales		% VA to Sales	60%	63%	60%
VA/Total Assets		Capital Productivity	99%	103%	114%
Sales/Total Assets		Rotation of Assets	1,67	1,63	1,90
Net Sales/Total Assets	I	Return on Assets	17,00%	18,81%	20,51%
Operating Profit/ Sales		Net Margin	10,33%	11,53%	10,84%
Net Sales/VA		Stakeholder distribution	73%	71%	72%
Personnel Costs/VA		Workers Distribution	17%	18%	18%
VA/# Workers		Labour Productivity	$ 6 632 214,39	$ 7 258 495,15	$ 8 027 628,68
Sales/ # Workers		Sales per Employee	$ 11 141 446,22	$ 11 512 477,41	$ 13 370 317,04
VA/Personnel Costs	II	Personnel Costs to VA	1,37	1,40	1,39
Total Assets/ # Workers		Total Capital Intensity	$ 6 680 219,82	$ 7 053 537,44	$ 7 033 179,80
VA/Fix Assets		Fixed Assets Capital Productivity	19,91%	26,94%	24,00%
Sales/Fixed Assets	III	Fixed Assets Capital Contribution to Sales	33,45%	42,72%	39,97%
Fixed Assets/# Workers		Fixed Assets Capital Intensity	$ 333 033,72	$ 269 473,53	$ 334 491,21

Table 4.5. VA Indexes of the textile company

The total asset rotation its productivity has been negatively affected in the utilization of total resources possibly by infrastructure improvements made in 2008. This lowered the performance level in total asset investment and its return on producing and generating sales. Nonetheless, the effect has deteriorated in 2010, due to the increase in trade accounts receivable. As for the return on assets, their final return on investments increased in all periods, which means a greater degree of effectiveness in the use of total assets. The net margin from 2008 to 2009 jumped from $10.33 to $11.53 whereas from 2009 to 2010, it declined of 0.68 percent-points (see Figure 4.13), caused by an increase in indirect manufacturing expense (wages) producing a loss of profit on sales. This small margin produces a low profit level that weakens the company's yields; likewise, it did not grow at the same pace as previous years.

To summarize, according to the table above, what emerges is shown below:

2008 Asset turnover was converted 1.67 times, which is considered as healthy in terms of sales. An effective use of resources where value is added (capital productivity) was seen: 99% of total asset investment. Also, the ability to gain in total assets to produce net profits was 17.23%. The ratio of sales that is left once all costs and expenses are

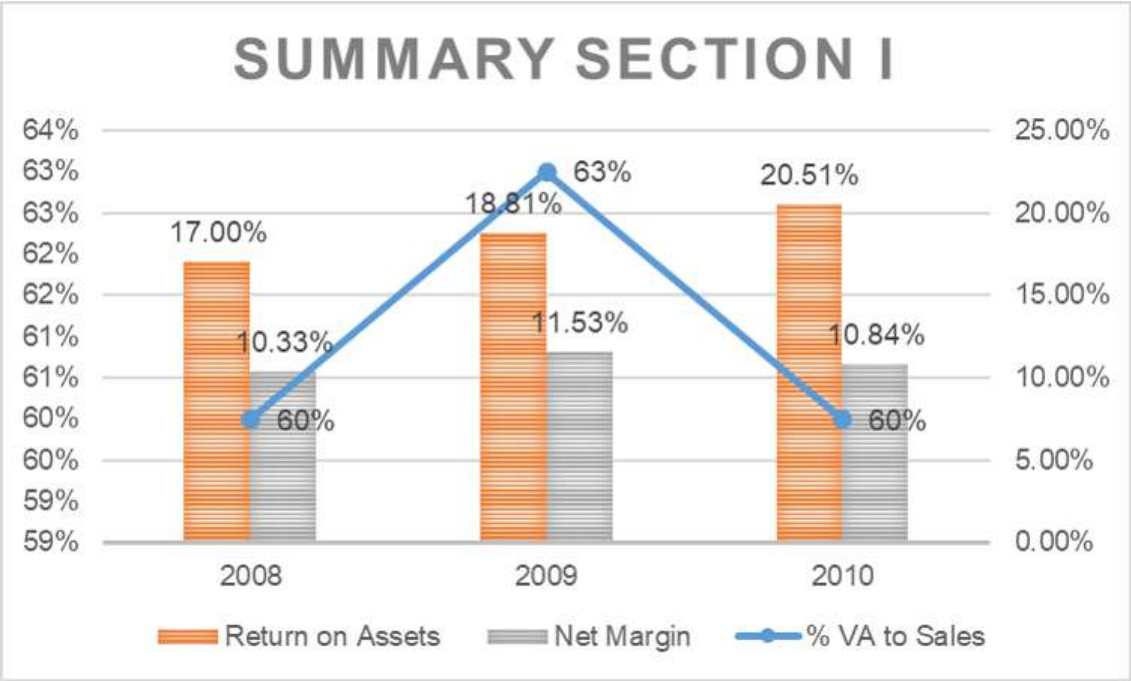

Figure 4.13. Summary of the Section I ratios

covered was $10.33 net income for every hundred dollars of sales; in addition, 60% of wealth was generated in relation to total sales.

2009 Asset turnover dropped by 1.63 times to sales; effective use of value-added resources was 103% of total asset investment. Additionally, the gain in total assets producing net profits was 18.81%. The proportion of sales once costs were covered was $11.53 net profit per hundred dollars of sales and 63% of wealth was generated in relation to total sales.

2010 Rotation of assets improved, turning it into sales 1.90 times, but generated 60% of wealth in relation to total sales; the real use of resources where value is added was 114% of total investment of assets. The gain in the ability of total assets to produce net profits was 20.61%. Finally, $10.84 net profit was obtained for every hundred dollars of sales.

In general, there is an upward trend from one year to the next, thereby depicting how senior executives properly tracked net sales, value added and asset turnover.

Wealth should be shared among all the stakeholders. Even when considering indices, it was not the company's policy to increase the benefits to workers according to the value-added ratio and it is rather done at the discretion of the owner. However, there is no doubt that worker participation contributes to the generation of the total wealth generated. Given this amount, the share for 2008 should be 73%, with a decrease in the following years due to the increase in wage expenses. This does not mean that these rates imply an increase in salary but in benefits in general (e.g. using a business physician, bonuses, reimbursement of transportation etc.).

On the other hand, the participation of the Investor, as per table above, indicates that the share of shareholders in 2008 was 17% and increased by one percentage point in the following two periods, from which it can become dividends.

Summarizing the distribution of value added by year:

2008 The portion that should be delivered on to employees is $73.00 per dollar generated from wealth. Likewise, investors' share of the wealth generated is 17%. .

2009 For each dollar of wealth generated, the amount of benefits that should be passed on to the employees is $71.00. Besides, 18% of wealth creation is estimated to be transferred to investors.

2010 The amount that should be given to all the workers is $72.00 per dollar of wealth generated. Similarly, the part of the wealth that must to be paid to investors is 18%.

Moving on to section II, this is associated with the workforce aspect. According to the same table, Labour Productivity has presented an increasing performance from 2008 to 2010 (see Figure 4.14), which means that the contribution of employees in richness was substantial as well as the managerial control of the worker part produced growth in those periods. This is a key determinant of the salary levels and profits, which is why it is important to keep this trend. With respect to sales per employee, the data indicates a slight increase for 2009 caused by an increase in the cost of labour. For 2010, more was sold with the same level of personnel over the three years, meaning that the employees' share was also growing.

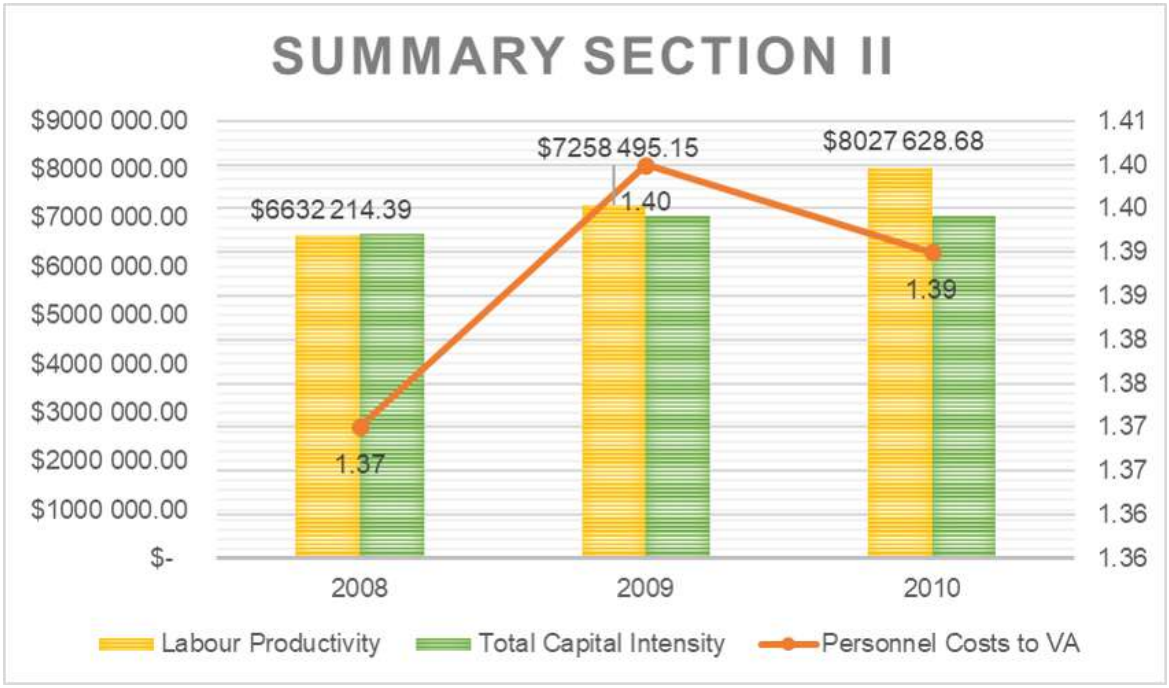

Figure 4.14. Summary of the Section II ratios

The Personnel Costs to Added Value describes how much of value added is attributable to the cost of personnel. The portion that the company passes to its employees was 1.37 times its value in 2008. Then, this rose in 2009 by 0.03 percentual points but fell

to 0.01 in 2010. Although the value added continued to grow, so did manufacturing overheads, specifically wages. On the other hand total capital intensity grew from 2008 to 2009 but decreased slightly for 2010, possibly because there was a strong investment by the company in terms of machinery and equipment. In addition, there was a decrease in the production of finished product and in process and an increase in raw material, according to their financial statements (not included in this work for confidentiality reasons), as illustrated in Figure 4.14. The human resource factor per year is shown below:

2008 The value-added employee contribution was $6.63 million, which resulted in $11.14 million in sales. The contribution of personnel costs to value added was 1.37%. Workers' involvement in the production of goods was $6.68 million.

2009 Employee contributions to value added amounted $7.25 million, translating into $11.51 million in sales. On the other hand, the contribution of personnel costs to value added increased to 1.40%. The employee engagement amount related toward manufacturing of goods was $7.05 million.

2010 Employees have contributed $8.02 million in value added, which has led to $13.37 million in sales. The contribution of personnel costs to value added was 1.39%. The employee contribution in the generation of tangible outputs was $7.03 million.

Finally, section III concerns the production parameters, which evaluates how productive the fixed assets were (buildings and infrastructure, machinery and equipment). The table above presents the Fixed Capital Assets Productivity - contribution of machines and equipment in the generation of wealth - which was of 19.91% for 2008. An incremental pattern remains for 2009 but a drop of 2.94 percentage points can be seen in 2010, most probably due to investment in machinery and equipment (see Figure 4.15).

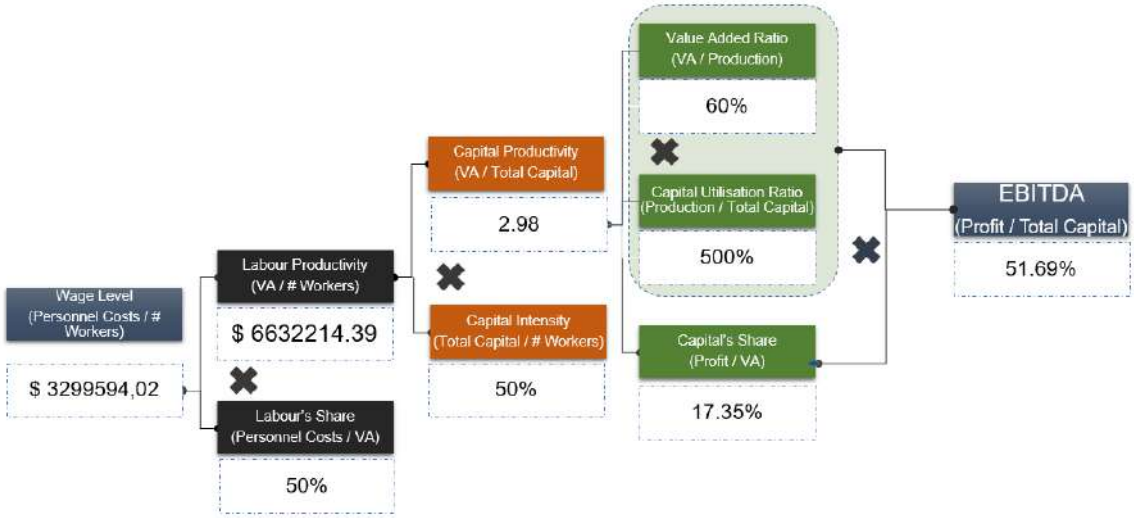

Figure 4.15. Labour Productivity and Profits relationship, year 2008 example

With respect to Fixed Assets Capital Contribution to Sales ratio, in 2008, fixed assets produced 33.45% sales, which increased again the following years. Investment in Fixed Assets means to contribute to production and operations to make sales possible, but

this implies a small sacrifice. This is what seems to have happened from 2009 to 2010 with the decrease of the indicator. Finally, the Fixed Assets Capital Intensity - reflecting the availability of machines and equipment for each employee while performing their activities - in 2008 was $333 million (see Figure 4.15). However, the contribution of machines and equipment per employee dropped $63,560.19 million in 2009 because of investments in fixed assets and again rose $65,017.68 million during the year 2010. On this point, the situation became as follows:

2008 Fixed assets' contribution to value added was $19.91 per dollar invested, which translated into $33.45 per dollar in sales. The machinery and equipment availability for employees to perform their duties was $333,033.72

2009 The contribution of fixed assets to value added was $26.94 per dollar invested, which translated into $42.72 per dollar in sales. The availability of machinery and equipment per worker to carry out his or her activities was $269,473.53.

2010 The fixed assets' contributed value added was $24.00 for every dollar spent, resulting in $39.97 for every dollar of sales. As for the availability of machines and equipment for each employee to perform their activities resulted in $334491.21.

Let us consider the productivity-profitability relationship. The elements participating to productivity are part labour ratios, through the wage level that measures the portion of the added value attributed to the cost of personnel. Under this assumption, Table 4.6 and Figure 4.16 provide an example of this link, which is an analysis for 2008, in which the salary level was $3,299,594/employee and had a growing trend in subsequent years.

RATIO	2008	2009	2010
Wage level	$ 3 299 594,02	$ 4 276 404,15	$ 4 589 716,30
Labour Productivity	$ 6 632 214,39	$ 7 258 495,15	$ 8 027 638,68
Labour Participation	49,75%	58,92%	57,17%
Capital Productivity	2,98	1,99	1,68
Capital Intensity	$ 2 226 196,02	$ 2 226 196,02	$ 4 784 271,49
VA ratio	59,53%	63,05%	60,04%
Capital Utilization ratio	500,47%	316,34%	279,46%
Capital Participation	17,35%	18,28%	18,06%
EBITDA	51,69%	36,46%	30,30%

Table 4.6. Productivity-Profitability data based on financial statements

On the other hand, in terms of profitability, for every dollar invested by the partners, the business has generated $51.69 in profits. According to the data of the same Table and the performance of the indexes (see Figure 4.17), there has been a marked decrease, for 2009 to 36.46% in profits, then another of 6.16 percentage points during 2010. This is caused by an increase in accounting capital (difference between assets and liabilities) for the concept of accumulated profit.

Figure 4.16. Productivity – Profitability behaviour of the company

2.2.2. Step Sustainability – Phase III Improvement Actions

Concerning the overall analysis of the situation of this SME, it is worth mentioning that accounting was not used to make decisions, but is merely seen as a useful instrument to comply with a tax obligation and show delays. It does not reveal the real economic and financial circumstances within the SME. It should be clear that, for the proper functioning of indexes, what is absolutely imperative is that the financial-accounting information provided is reliable, otherwise, the validity of the analysis of the data could be affected. It is crucial for a good diagnosis and for making decisions to be based on both operational and strategic data.

In this case, as can be seen in Figure 4.15, one of the points highlighted by the VAPMs is the efficient operation of fixed assets. In this regard, management has reported that during 2009, they have invested in machinery and equipment, which has led to lower levels of means of production productivity. But, going into it further, weaknesses were found in the layout, as documented in the process flow diagram. The diagram shows several cross lines and too much transports, which could means doubled routes of materials, time loss, operator fatigue due to distances to be covered, and more. Additionally, there was evidence of poor production planning and quality control. Corrective maintenance prevails, which represents the main element that interferes with the provision of an adequate response time to a customer's order.

All these findings are characteristic of SMEs in general. The use of VAPM allows the calculation of indicators on the aspects that the company is interested in improving in order to reduce costs and therefore increase profits in a simple way. By complementing it with simple tools, it may provide a great potential for business intelligence.

In terms of the proposed model, the implementation of VAPM follows the hypothesis 2 and 3, outlined in Chapter 2, concerning the monitoring of the Lean strategy. It also concerns Phases II and III of the model with respect to the PDCA spiral (see Figure

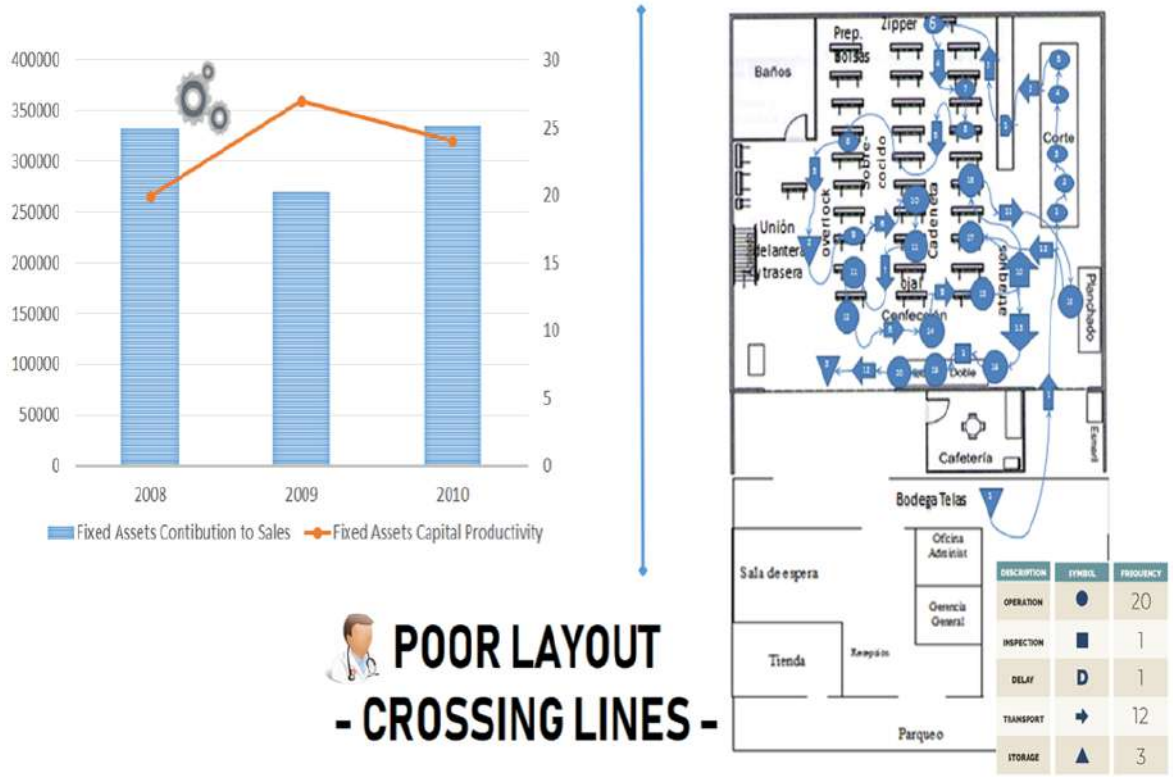

Figure 4.17. Fixed Assets Capital Productivity findings

3.18) by the diagnosis of the situation of SMEs and recommendations for improvement. Then, viewing LP as a complex system, it would encompass levels 1 and 2 (see Figures 3.6, 3.7 and 3.20) as it diagnoses how the company has handled its resources, which is the basis for its survival and can be further detailed through socio-technical and cost reduction considerations. Finally, in relation to the BSC structure, it will be audited directly within the dimensions of Finance, Customer and Internal Process, especially.

3. Conclusions

In this chapter, we have tried to validate the proposed methodology through the subsequent analysis of a series of real examples applied individually in two Costa Rican companies. These examples do not represent the entire Lean deployment methodology. In all these examples, with the exception of the latter, the concept of holistic productivity has been implemented within the company.

Under this context, in the first case, the 5S program constitutes the starting point for the required behavioural shift and allows a better understanding of the true nature of the programme. However, in order to measure the real 5S impact upon behaviour, periodical audits must be conducted, with much set the emphasis on Seiketsu and Shitsuke as criteria for estimating attitudinal change. The 5S auditing protocol should include the checklist so that the rating method of internal competence and encouragement of improvement actions. This has been proposed but not applied.

The following applications are based on the Kaizen strategy, are conducted by 5S synergy and are oriented towards critical issues (PQCDSMEI). The occupational safety scenario allows to highlight what the holistic productivity approach is really looking for, where awareness about the subject is perceived at all organisational levels within the business. Other examples of 5S and Kaizen in relation to other critical issues are maintenance (case 3 and 4), environment (case 5) and production process (case 6). It should be noted that despite the achievements over a period of 3 years, the company did not continue with the efforts already made by internal policies of the parent company with the change of senior management levels. Likewise, all these initiatives would form part of Phase I of the proposed methodology (see Figure 3.18, previous chapter).

Finally, case 7, dealing with the value added productivity measurement in an SME of the textile sector, enabled us to validate the application of Phases II and III. In this case, the financial statements are used to determine the wealth generated level (Value Added) and with allow to obtain indexes to diagnose where the constraints are, then to offer solutions. This aspect has a high potential for development in business intelligence, especially for SMEs.

The rest of the Phases remains to be validated.

General Conclusion

Lean represents today a fundamental and critical foundation at the heart of the performance of organizations aiming to be more competitive. Its solid base is the origin of the successes but also of the failures of its deployment. Poorly managed development processes can lead to a loss of market position, which results in significant financial losses.

On the other hand, efficient and well-managed development processes can provide competitive advantages by providing access to very interesting and profitable sales opportunities in different markets, presenting products that integrate customer needs and satisfy the strategic ambitions of the business. However, over time, it can be seen that the implementation of Lean has been very heterogeneous and often very difficult to manage, as many implementations have been based on a very simplistic and short-term logic. Moreover, in the case of SMEs, many do not fully understand LP principles and, on many occasions, are forced by large corporations to apply it within supplier development programs. Therefore, its implementation has often been very superficial. The challenge is to transform these iterative attempts in consistent processes where Lean principles satisfy the expected results.

Our research on this topic is based on the scientific literature and on my industrial experience, which allowed me to identify different barriers that the Lean initiative has had in business. In this sense, the main objective of this research was to propose a methodology whose solid bases allow a more flexible and sustainable deployment of the Lean strategy towards a learning organization. More specifically, within the framework of this thesis, we propose a transformation model to guide industrialists in the construction of a roadmap and its deployment according to the holistic approach to productivity. The model supports the identification and prioritization of improvement initiatives focusing on productivity levers and continuous improvement.

To build this transformational methodology, we began our work by demonstrating that there were knowledge transfer problems during the benchmarking period performed by U.S. experts. The review of the scientific literature and my personal experience led me to propose some conceptual scientific contributions. More specifically, holistic productivity was proposed as well as the analysis of Lean as a system of systems. This is meaningful given the great confusion and disparity with which LP has been addressed in the current scientific literature. Also, this led us to think that this strategy has been directed in an "*aggregated*" way, where the results are the sum of their individual parts. Thereafter, we proposed a strategic framework to link these potential improvement

levers to an organization's performance objectives in order to integrate customer need through an analysis of the socio-technical context, performance measurement and strategic ambitions in the transformation process. This allowed us to establish a link between the elements of the Lean system related to continuous improvement and respect for human beings with respect to tools.

Within the feedback of the author's know-how and improvement models presented in the scientific literature, we were able to propose a model that encompasses the initial stage of a Lean learning organization. This ranges from the identification of transformation objectives to the management of recommended operational improvement projects in a coherent roadmap and under the structure offered by BSC. This contribution, both technical in terms of application of Lean tools and techniques and methodological in terms of proposing a rigorous approach, was developed iteratively. The industrial input is noteworthy in a field where most scientific journals and publications are limited to presenting concepts, tools and techniques without guiding industrialists who wish to improve their product development processes from an operational point of view.

The industrial validation was done through real cases at the industrial level. These cases generated positive results that could be measured on the basis of productivity indicators. In particular, the various productive areas of the value chain of the considered companies have benefited from an increase in both quantitative and qualitative performance. These results allow us to confirm that the efficient deployment of Lean tools and techniques can improve business competitiveness. However, the application of the proposed singular approach, centered on a sequence of activities to deploy Lean tools and techniques, has been validated only partially. Making more comprehensive validations would be the next step to reinforce the proposal.

This research proposal is a rather incremental approach, i.e. one that is carried out over many improvement phases. Furthermore, the tools can be improved and adapted to changes the organization's operating methods to take account the strategic needs of the company. In the same sense, we believe that the model has great potential to adapt to different industrial sectors. The strength of the model lies in a solid conceptual support and the interaction between its elements, but its transformation takes time.

An additional research perspective that we find interesting would be the development of a mathematical modeling supporting such methodological approach. This kind of development would allow us to optimize the settings by integrating additional constraints. This would also allow us to develop a dynamic computer tool or application that supports the generation of a progress plan and the associated management system.

Bibliography

Achanga, P., Shehab, E., Roy, R., and Nelder, G. (2006). Critical success factors for lean implementation within smes. *Journal of Manufacturing Technology Management*, 17(4):460–471.

Åhlström, P. (1998). Sequences in the implementation of lean production. *European Management Journal*, 16(3):327–334.

Almeida Marodin, G. and Saurin, T. A. (2013). Implementing lean production systems: research areas and opportunities for future studies. *International Journal of Production Research*, 51(22):6663–6680.

Almeida Marodin, G. and Saurin, T. A. (2015). Managing barriers to lean production implementation: context matters. *International Journal of Production Research*, 53(13):3947–3962.

Anderson, D. and Anderson, L. A. (2010). *Beyond change management: How to achieve breakthrough results through conscious change leadership*. John Wiley & Sons.

Anderson, J. C., Rungtusanatham, M., and Schroeder, R. G. (1994). A theory of quality management underlying the deming management method. *Academy of management Review*, 19(3):472–509.

Arteta, B. and Giachetti, R. (2004). A measure of agility as the complexity of the enterprise system. *Robotics and computer-integrated manufacturing*, 20(6):495–503.

Asian Productivity Organisation (2014). *Manual on Labor-Management Relations: Japanese Experiences and Best Practices*. Asian Productivity Organisation, Leaf Square Hongo Building, 2F. 1-24-1 Hongo, Bunkyo-ku Tokyo 113-0033, Japan.

Asian Productivity Organisation (2015). *Handbook for SME Productivity Measurement and Analysis for NPO's*. Asian Productivity Organisation, Leaf Square Hongo Building 2F, 1-24-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan.

Atkinson, P. (2010). Lean is a cultural issue. *Management Services*, 54(2):35–41.

Atkinson, R. D. (2013). Competitiveness, innovation and productivity. *The Information Technology & Innovation Foundation.–August*, pages 2–7.

Bernhauerova, M. (2013). American vs. japanese management style: Which one yields success. *MG 201, Introduction to Functions of Management*.

Berry, B. (2011). There is a relationship between systems thinking and w. edwards deming's theory of profound knowledge. *Retrieved August*, 25:2011.

Bhasin, S. (2008). Lean and performance measurement. *Journal of Manufacturing Technology Management*, 19(5):670–684.

Bhasin, S. (2012). Prominent obstacles to lean. *International Journal of Productivity and Performance Management*, 61(4):403–425.

Bhasin, S. and Burcher, P. (2006). Lean viewed as a philosophy. *Journal of manufacturing technology management*, 17(1):56–72.

Bicheno, J. and Holweg, M. (2016). *The lean toolbox. A handbook for Lean transformation (5th Edition)*, volume 4. PICSIE books Buckingham.

Birdi, K., Clegg, C., Patterson, M., Robinson, A., Stride, C. B., Wall, T. D., and Wood, S. J. (2008). The impact of human resource and operational management practices on company productivity: A longitudinal study. *Personnel Psychology*, 61(3):467–501.

Bloom, N. and Van Reenen, J. (2011). Human resource management and productivity. *Handbook of labor economics*, 4:1697–1767.

Bonavia, T. and Marin-Garcia, J. A. (2011). Integrating human resource management into lean production and their impact on organizational performance. *International Journal of Manpower*, 32(8):923–938.

Bortolotti, T., Boscari, S., and Danese, P. (2015). Successful lean implementation: Organizational culture and soft lean practices. *International Journal of Production Economics*, 160:182–201.

Brosnahan, J. P. (2008). Unleash the power of lean accounting. *Journal of Accountancy*, 206(1):60.

Browning, T. R. and Heath, R. D. (2009). Reconceptualizing the effects of lean on production costs with evidence from the F-22 program. *Journal of Operations Management*, 27(1):23–44.

Cao, Y., Zhao, K., Yang, J., and Xiong, W. (2015). Constructing the integrated strategic performance indicator system for manufacturing companies. *International Journal of Production Research*, 53(13):4102–4116.

Carder, B. and Monda, M. (2013). Deming's profound knowledge and leadership. we are still not "out of the crisis". Technical report, ASQ, Human Development & Leadership Division.

Cassell, C., Worley, J., and Doolen, T. (2006). The role of communication and management support in a lean manufacturing implementation. *Management Decision*, 44(2):228–245.

Castle, D. and Jacobs, F. (2011). Apics operations management body of knowledge framework. *Chicago, IL: APICS*.

Chew, W. B. (1988). No-nonsense guide to measuring productivity. *Harvard Business Review*, 66(1):110.

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., and Battese, G. E. (2005). *An Introduction to Efficiency and Productivity Analysis*. Springer Science & Business Media.

Cravvford, K. M., Jr., J. H. B., and Cox, J. F. (1988). A study of jit implementation and operating problems. *International Journal of Production Research*.

Crute, V., Ward, Y., Brown, S., and Graves, A. (2003). Implementing Lean in aerospace challenging the assumptions and understanding the challenges. *Technovation*, 23(12):917–928.

Cusins, P. (1994). Understanding quality through systems thinking. *The TQM Magazine*, 6(5):19–27.

De Langhe, B., Puntoni, S., and Larrick, R. P. (2017). Linear thinking in a nonlinear world. *Harvard Business Review*, 2017(May-June):11.

de Menezes, L. M., Wood, S., and Gelade, G. (2010). The integration of human resource and operation management practices and its link with performance: A longitudinal latent class study. *Journal of Operations Management*, 28(6):455–471.

Deming, E. W. (1982). *Quality, productivity, and competitive position*, volume 183. Massachusetts Institute of Technology, Center for advanced engineering study Cambridge, MA.

Dombrowski, U. and Mielke, T. (2014). Lean Leadership 15 Rules for a Sustainable Lean Implementation. *Procedia CIRP*, 17:565–570.

Drucker, P. (2012). *The practice of management*. Routledge.

Drucker, P. F. (1995). The new productivity challenge. *Quality in Higher Education*, 37:45–53.

Drucker, P. F. (1999). Knowledge-worker productivity: The biggest challenge. *California management review*, 41(2):79–94.

EANPC (2005). Productivity, the high road to wealth.

Emiliani, M. (2000). Cracking the code of business. *Management Decision*, 38(2):60–79.

Emiliani, M. and Stec, D. (2005). Leaders lost in transformation. *Leadership & Organization Development Journal*, 26(5):370–387.

Evans, T. J. (1996). Deming's system of profound knowledge: An overview for international educators.

Fukuda, Y. and Sase, T. (1994). *Integrated Productivity & Quality improvement (IPQI) for productivity facilitators*.

Fullerton, R. R., Kennedy, F. A., and Widener, S. K. (2014). Lean manufacturing and firm performance: The incremental contribution of lean management accounting practices. *Journal of Operations Management*, 32(7):414–428.

Fullerton, R. R. and Wempe, W. F. (2009). Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Operations & Production Management*, 29(3):214–240.

Furlan, A., Vinelli, A., and Dal Pont, G. (2011). Complementarity and lean manufacturing bundles: an empirical analysis. *International Journal of Operations & Production Management*, 31(8):835–850.

Galichet, G. (2018). *Proposition d'une méthodologie de transformation organisationnelle pour une performance industrielle et de la santé au travail*. PhD thesis, Paris Saclay.

Gapp, R., Fisher, R., and Kobayashi, K. (2008). Implementing 5s within a japanese context: an integrated management system. *Management Decision*, 46(4):565–579.

Gilbert, J. P. (1990). The state of jit implementation and development in the usa. *THE INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH*, 28(6):1099–1109.

Grabot, B. and Mayere, A. (2009). Sme and planning in supply chains: A socio-technical view. In *International Conference on Engineering and Systems Management 09*.

Gregory, A. (2007). Target setting, lean systems and viable systems: a systems perspective on control and performance measurement. *Journal of the Operational Research Society*, 58(11):1503–1517.

Groves, K., Vance, C., and Paik, Y. (2008). Linking linear/nonlinear thinking style balance and managerial ethical decision-making. *Journal of Business Ethics*, 80(2):305–325.

Gunasekaran, A. and Kobu, B. (2007). Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995–2004) for research and applications. *International journal of production research*, 45(12):2819–2840.

Gunasekaran, A. and Ngai, E. W. (2012). The future of operations management: an outlook and analysis. *International Journal of Production Economics*, 135(2):687–701.

Haghirian, P. (2010). *Understanding Japanese management practices*. Business Expert Press.

Halling, B. and Wijk, K. (2013). Experienced barriers to lean in swedish manufacturing and health care. *International Journal of Lean Thinking*, 4(2).

Hampson, I. (1999). Lean production and the toyota production system or, the case of the forgoften production concepts. *Economic and industrial democracy*, 20(3):369–391.

Hines, P., Holweg, M., and Rich, N. (2004). Learning to evolve: a review of contemporary lean thinking. *International Journal of Operations & Production Management*, 24(10):994–1011.

Hirano, H. (2009). *JIT Implementation Manual–The Complete Guide to Just-In-Time Manufacturing: Volume 2–Waste and the 5S's*. CRC Press.

Holweg, M. (2007). The genealogy of lean production. *Journal of Operations Management*, 25(2):420–437.

Holweg, M. and Helo, P. (2014). Defining value chain architectures: Linking strategic value creation to operational supply chain design. *International Journal of Production Economics*, 147:230–238.

Jackson, M. C. (2003). *Systems thinking: Creative holism for managers*. Wiley Chichester.

Japan Productivity Center (1988). *Introduction to the Roles of Productivity Facilitator*.

JICA (2011). Handbook of national movements for quality and productivity improvement (kaizen). Technical report, Japan International Cooparation Agency.

Jones, P. (2016). *Strategy mapping for learning organizations: building agility into your balanced scorecard*. Routledge.

Joosten, T., Bongers, I., and Janssen, R. (2009). Application of lean thinking to health care: issues and observations. *International Journal for Quality in Health Care*, 21(5):341–347.

Kaplan, R. S. and Norton, D. P. (2001a). Transforming the balanced scorecard from performance measurement to strategic management: Part i. *Accounting horizons*, 15(1):87–104.

Kaplan, R. S. and Norton, D. P. (2001b). Transforming the balanced scorecard from performance measurement to strategic management: Part ii. *Accounting Horizons*, 15(2):147–160.

Kaplan, R. S. and Norton, D. P. (2008). Mastering the management system. *Harvard business review*, 86(1):62.

Kasser, J. E. (2015). *Holistic Thinking: creating innovative solutions to complex problems*. Right Requirement.

Katayama, H. (2017). Legend and future horizon of lean concept and technology. *Procedia Manufacturing*, 11:1093–1101.

Katayama, H. and Bennett, D. (1996). Lean production in a changing competitive world: a japanese perspective. *International Journal of Operations & Production Management*, 16(2):8–23.

Khanchanapong, T., Prajogo, D., Sohal, A. S., Cooper, B. K., Yeung, A. C., and Cheng, T. (2014). The unique and complementary effects of manufacturing technologies and lean practices on manufacturing operational performance. *International Journal of Production Economics*, 153:191–203.

Kobayashi, K., Fisher, R., and Gapp, R. (2008). Business improvement strategy or useful tool? analysis of the application of the 5s concept in japan, the uk and the us. *Total Quality Management*, 19(3):245–262.

Kono, T. and Clegg, S. (2001). *Trends in Japanese management: Continuing strengths, current problems and changing priorities*. Springer.

Kotter, J. P. and Schlesinger, L. A. (1989). Choosing strategies for change. In *Readings in Strategic Management*, pages 294–306. Springer.

Kotter, J. R. (2007). Leading change-why transformation efforts fail. *Harvard business review*, 85(1):96–+.

Leandro, R. (2007). Primero hacemos gente antes que productos y servicios. *TEC Empresarial*, 1(4):20–26.

Leandro-Elizondo, R., Grabot, B., and Houe Ngouna, R. (2016). Beyond productivity and continuous improvement: Fundamentals required for lean complex transformation. In *8th IFAC Conference on Manufacturing Modelling, Management and Control MIM 2016: Troyes, France, 28 - 30 June 2016*.

Lewis, M. A. (2000). Lean production and sustainable competitive advantage. *International Journal of Operations & Production Management*, 20(8):959–978.

Liker, J. K. (1997). *Becoming Lean: Inside Stories of U.S. Manufacturers*. Productivity Press.

Liker, J. K. (2005). *The toyota way*. Esensi.

Lillrank, P. (1995). The transfer of management innovations from japan. *Organization studies*, 16(6):971–989.

Lodgaard, E., Ingvaldsen, J. A., Gamme, I., and Aschehoug, S. (2016). Barriers to lean implementation: Perceptions of top managers, middle managers and workers. *Procedia CIRP*, 57:595–600.

Losonci, D., Demeter, K., and Jenei, I. (2011). Factors influencing employee perceptions in lean transformations. *International Journal of Production Economics*, 131(1):30–43.

Mankins, M. (2017). Great companies obsess over productivity, not efficiency. *Harvard Business Review*.

Mankins, M. C. and Steele, R. (2005). Turning great strategy into great performance. *Harvard business review*, 2607.

Marcotte, F., Grabot, B., and Affonso, R. (2008). Cooperation models for supply chain management. *International Journal of Logistics Systems and Management*, 5(1-2):123–153.

Martinez De Ita, M. E. (1995). El concepto de productividad en el analisis economico. *México. Texto Completo en: http://www. redem. buap. mx/acrobat/eugenia1. pdf*.

Martinez-Jurado, P. J. and Moyano-Fuentes, J. (2014). Lean Management, Supply Chain Management and Sustainability: A Literature Review. *Journal of Cleaner Production*, 85:134–150.

Martinez-Jurado, P. J., Moyano-Fuentes, J., and Jerez-Gomez, P. (2014). Human resource management in Lean Production adoption and implementation processes: Success factors in the aeronautics industry. *BRQ Business Research Quarterly*, 17(1):47–68.

Maskell, B. H., Baggaley, B., and Grasso, L. (2011). *Practical lean accounting: a proven system for measuring and managing the lean enterprise*. CRC Press.

Maskell, B. H. and Baggaley, B. L. (2006). Lean accounting: What's it all about? *Target*, 22(1):35–43.

Meade, D., Kumar, S., and White, B. (2010). Analysing the impact of the implementation of lean manufacturing strategies on profitability. *Journal of the Operational Research Society*, 61(5):858–871.

Melton, T. (2005). The benefits of lean manufacturing: what lean thinking has to offer the process industries. *Chemical engineering research and design*, 83(6):662–673.

Mi Dahlgaard-Park, S. and Pettersen, J. (2009). Defining lean production: some conceptual and practical issues. *The TQM Journal*, 21(2):127–142.

Miller, B. and Atkinson, R. (2014). Raising european productivity growth through ict.

Moeuf, A., Tamayo, S., Lamouri, S., Pellerin, R., and Lelievre, A. (2016). Strengths and weaknesses of small and medium sized enterprises regarding the implementation of lean manufacturing. *IFAC-PapersOnLine*, 49(12):71–76.

Morieux, Y. (2011). Smart rules: Six ways to get people to solve problems without you. *Harvard Business Review*, 89(9):78–86.

Mourtzis, D., Papathanasiou, P., and Fotia, S. (2016). Lean rules identification and classification for manufacturing industry. *Procedia CIRP*, 50:198–203.

Murata, K. and Katayama, H. (2010). Development of kaizen case-base for effective technology transfer–a case of visual management technology. *International Journal of Production Research*, 48(16):4901–4917.

Nakane, J. and Hall, R. W. (2002). Ohno's method. *Target*, 18(1):6–15.

Netland, T. H. and Ferdows, K. (2016). The s-curve effect of lean implementation. *Production and Operations Management*, 25(6):1106–1120.

Office for National Statistics, Great Britain. (2007). *The ONS productivity handbook: a statistical overview and guide*. Palgrave Macmillan.

Ohno, I., Ohno, K., Uesu, S., Ishiwata, A., Hosono, A., Kikuchi, T., and Uenda, T. (2009). Introducing kaizen in africa. In *GRIPS Development Forum*.

Ohno, T. (2012). *Taiichi Ohnos Workplace Management: Special 100th Birthday Edition*. McGraw Hill Professional.

Patel, S. (2016). *The Global Quality Management System: Improvement Through Systems Thinking*. CRC Press.

Pavnaskar, S., Gershenson, J., and Jambekar, A. (2003). Classification scheme for lean manufacturing tools. *International Journal of Production Research*, 41(13):3075–3090.

Pearce, A. and Pons, D. (2013). Implementing lean practices: managing the transformation risks. *Journal of industrial engineering*, 2013.

Pettersen, J. (2009). Defining lean production: some conceptual and practical issues. *The TQM Journal*, 21(2):127–142.

Porter, M. (2011). Innovation and competitiveness. The Global Competitiveness Forum.

Porter, M. E. (1996). What is strategy. *Published November*.

Porter, M. E. and Michael (2001). Strategy and the internet.

Poveda-Bautista, R., Baptista, D. C., and García-Melón, M. (2012). Setting competitiveness indicators using bsc and anp. *International Journal of Production Research*, 50(17):4738–4752.

Powell, D., Alfnes, E., Strandhagen, J. O., and Dreyer, H. (2013). The concurrent application of lean production and ERP: Towards an ERP-based lean implementation process. *Computers in Industry*, 64(3):324–335.

Prokopenko, J. (2000). Globalization, Competitiveness and Productivity Strategies: Enterprise and Management Development Working Paper. *J. Prokopenko. Geneva: International Labor Organization*.

Prokopenko, J. and North, K. (1996). *Productivity and Quality Management: A modular programme*. International Labour Office.

Rauch, E., Dallasega, P., and Matt, D. T. (2017). Critical factors for introducing lean product development to small and medium sized enterprises in italy. *Procedia CIRP*, 60:362–367.

Roll, D. (2008). An introduction to 6s. *Vital Enterprises*.

Rüttimann, B. G. and Stöckli, M. T. (2016). Going beyond triviality: The toyota production system-lean manufacturing beyond muda and kaizen. *Journal of Service Science and Management*, 9(02):140.

Saad, S., Perera, T., Achanga, P., Shehab, E., Roy, R., and Nelder, G. (2006). Critical success factors for lean implementation within smes. *Journal of Manufacturing Technology Management*, 17(4):460–471.

Scherrer-Rathje, M., Boyle, T. A., and Deflorin, P. (2009). Lean, take two! Reflections from the second attempt at lean implementation. *Business Horizons*, 52(1):79–88.

Schmidt, S. (2011). From hype to ignorance-a review of 30 years of lean production. *World Academy of Science, Engineering and Technology*, 73:1021–1024.

Schonberger, R. J. (2007). Japanese production management: An evolution With mixed success. *Journal of Operations Management*, 25(2):403–419.

Seddon, J. and Caulkin, S. (2007). Systems thinking, lean production and action learning. *Action Learning: Research and Practice*, 4(1):9–24.

Seddon, J. and O'Donovan, B. (2010). Why aren't we all working for learning organisations. *AMED e-Organisations and People*, 17(2).

Sen, A. K. (1977). Rational fools: A critique of the behavioral foundations of economic theory. *Philosophy & Public Affairs*, pages 317–344.

Senge, P. M. (1991). The fifth discipline, the art and practice of the learning organization. *Performance+ Instruction*, 30(5):37–37.

Shah, R., Chandrasekaran, A., and Linderman, K. (2008). In pursuit of implementation patterns: the context of lean and six sigma. *International Journal of Production Research*, 46(23):6679–6699.

Shah, R. and Ward, P. T. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of operations management*, 21(2):129–149.

Shah, R. and Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of operations management*, 25(4):785–805.

Sherehiy, B., Karwowski, W., and Layer, J. K. (2007). A review of enterprise agility: Concepts, frameworks, and attributes. *International Journal of industrial ergonomics*, 37(5):445–460.

Shimada, G. and Sonobe, T. (2016). Impacts of kaizen management on workers: Evidence from the central america and caribbean region. *JICA*.

Shimada, H. and MacDuffie, J. P. (1986). Industrial relations and" humanware"–japanese investments in automobile manufacturing in the united states.

Shimizu, M., Wainai, K., Nagal, K., et al. (1991). Value added productivity measurement and practical approach to management improvement.

Singapore, S. (2011). A Guide to Productivity Measurement, south tower Singapore.

Snowdon, B. and Stonehouse, G. (2006). Competitiveness in a globalised world: Michael porter on the microeconomic foundations of the competitiveness of nations, regions, and firms. *Journal of international business studies*, 37(2):163–175.

Spring, S. (2011). A guide to integrated management of productivity activities (impact). *Spring Singapore*.

Stainer, A. (1995). Productivity management: the japanese experience. *Management Decision*, 33(8):4–12.

Stainer, A. (1997). Logistics-a productivity and performance perspective. *Supply Chain Management: An International Journal*, 2(2):53–62.

Sterman, J. D. (2002). Systems dynamics modeling: tools for learning in a complex world. *Engineering Management Review, IEEE*, 30(1):42–42.

Stevens, T. (1994). Dr deming: management today does not know what its job is. *Industry Week*, 243(2):20–7.

Štrach, P. and Everett, A. M. (2006). Knowledge transfer within japanese multinationals: building a theory. *Journal of Knowledge Management*, 10(1):55–68.

Suárez-Barraza, M. F., Ramis-Pujol, J., and Kerbache, L. (2011). Thoughts on kaizen and its evolution: Three different perspectives and guiding principles. *International Journal of Lean Six Sigma*, 2(4):288–308.

Sunaga, K. (2006). L'essence du mouvement de productivité-une étude á partir des sources américaines. *Histoire, économie & société*, 25(2):261–279.

Susilawati, A., Tan, J., Bell, D., and Sarwar, M. (2015). Fuzzy logic based method to measure degree of lean activity in manufacturing industry. *Journal of Manufacturing Systems*, 34:1–11.

Suzuki, H. (1993). *Practical kaizen for productivity facilitators*.

Syverson, C. (2010). What determines productivity? Technical report, National Bureau of Economic Research.

Takemura, Kenji; Vajna, I. and Vajna-Istvanne, A. (2016). The role of prouctivity development of new dual 5s card system and daily lean management.

Takemura, K. (2002). Kaizen training activities at holcim. Technical report, CEFOF-JICA.

Tangen, S. (2004). Performance measurement: from philosophy to practice. *International journal of productivity and performance management*, 53(8):726–737.

Taylor, A., Taylor, M., and McSweeney, A. (2013). Towards greater understanding of success and survival of lean systems. *International Journal of Production Research*, 51(22):6607–6630.

Toyota, M. C. (2014). Sustainability Report 2014. Technical report, Toyota Motor Corporation.

Tsuchiya, K. (1998). Super 5s for everyone.

Watson, G. H. (2002). Peter f. drucker: Delivering value to customers. *Quality Progress*, 35(5):55.

Womack, J. P. and Jones, D. T. (2010). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. Simon and Schuster.

Womack, J. P., Jones, D. T., and Roos, D. (1990). *The Machine That Changed the World*. Simon and Schuster.

Worley, J. and Doolen, T. (2006). The role of communication and management support in a lean manufacturing implementation. *Management Decision*, 44(2):228–245.

Yacuzzi, E. (2007). El management japonés: una revisión de su literatura. parte ii: aspectos originales, críticas y desafíos. Technical report, Serie Documentos de Trabajo, Universidad del CEMA: Área negocios.

Résumé

Actuellement, les pratiques de Lean Management représentent un avantage compétitif pour la majorité des entreprises qui cherchent à améliorer leur performance dans un marché mondial très agressif. Le processus de mise en œuvre du Lean est très complexe ; il s'agit de se transformer en une nouvelle philosophie et de gérer l'entreprise - un changement de comportement. Ce document passe en revue la documentation relative aux pratiques de Lean Management et à l'incapacité de certaines entreprises à maintenir les résultats dans le temps, en particulier sur le décalage entre les objectifs du Lean et leurs efforts de mise en œuvre pour éliminer le gaspillage par l'amélioration des processus. La littérature a relevé plusieurs problèmes de gestion concernant ce problème, mais les principales raisons en sont, d'une part, une rupture des interfaces entre les aspects sociotechniques et, d'autre part, un besoin d'engagement réel de la part de la direction générale. Par conséquent, l'objectif de cet étude est de synthétiser et d'analyser ces difficultés Lean sur la base d'une pensée systémique dynamique et de proposer en plus, comme alternative à une proposition classique (linéarité) pour résoudre ces problèmes Lean, deux hypothèses : la contribution de la productivité qui réduit ces écarts, de manière plus globale ; en plus, sur l'approche de l'amélioration continue, qui permet de mesurer les "changements comportementaux" et encourage également la participation ; elle pose également le problème des performances chez des employés autonomes qui ont été documentés dans la documentation Lean.

Keywords : Kaizen, Amélioration des processus opérationnels, Systèmes complexes, Lean Management, Qualité, Gestion de la productivité, Facteurs socio-techniques

Abstract

Currently, Lean Management Practices represents a competitive advantage for most companies trying to raise their performance in a very aggressive global market. Lean's implementation process is very complex; it means to transform into a new philosophy and managing the business - a behaviour change. This paper reviews the literature in relation to Lean managerial practices and the incapacity for some companies to sustain the results over time; specifically about the misalignment among the Lean's purposes with their implementation efforts to waste elimination through the improvement of processes. The literature found several management issues regarding this problematic but the main reasons are: firstly a break down interfaces between socio-technical aspects and secondly, a need of real commitment from the top management. Consequently, the target of this paper is to synthesize and analyse those Lean difficulties based on dynamic system thinking and, also, to propose two assumptions as an alternatives to a conventional proposals (linearity) to solve this Leans' problems: the contribution of productivity management which narrows these gaps, in a more holistic manner; in addition, based on the continuous improvement approach as a metric to assess Lean's "*behaviour change*" and also to encourage commitment; it also engages the performance dilemma throughout empowered workers that has been documented in the Lean literature.

Keywords : Kaizen, Business Process Improvement, Complex Systems, Lean Management, Quality, Productivity Management, Socio-technical factors